21-1

IID-353

IMPERIAL IRRIGATION DISTRICT

INTER-OFFICE MEMORANDUM

TO Water Conservation Advisory Board

COPIES TO

DATE August 9, 1990

FROM Secretary, WCAB

DEPARTMENT Water

AT Imperial

SUBJECT Percent of Tailwater by Crop

The following is a table, by crop, of the average delivery, tailwater, and percent tailwater that were measured during the course of the District's Irrigation Scheduling Program.

	Average Del. (AF)	Average T.W. (AF)	Average T.W. (%)	Number of Records
1. Alfalfa (FC)	36.3	4.8	13	4259
2. Row Alfalfa (RC)	41.6	8.7	21	829
3. Sugar Beets (RC)	36.1	7.6	21	669
4. Cotton (RC)	34.1	6.3	18	615
5. Wheat (FC)	36.1	5.2	14	470
6. Bermuda Grass (FC)	33.0	5.2	16	280
7. Sudan Grass (FC)	40.8	6.1	15	154
8. Onions (RC)	24.6	7.0	28	92
9. Flat Flood	77.6	4.9	6	73
10. Melons	24.8	4.2	17	48
TOTALS	38.5	6.0	15.6	7489
Flat Crops (FC)	36.6	5.3	14.5	5163
Row Crops (RC)	34.1	7.4	21.7	2205

Some of the immediate questions that come to mind are:

- Were their predominately good (or bad) users in the program?

- Are some of the smaller sets statistically significant?

- What was the true accuracy of our measurement structures?

These numbers are not statistically "weighted" to reflect the actual crop percentages that exist in the District. However, my overall feeling is that these are as good as numbers as the district has at the present time, and that we can use them with a relatively high degree of confidence.

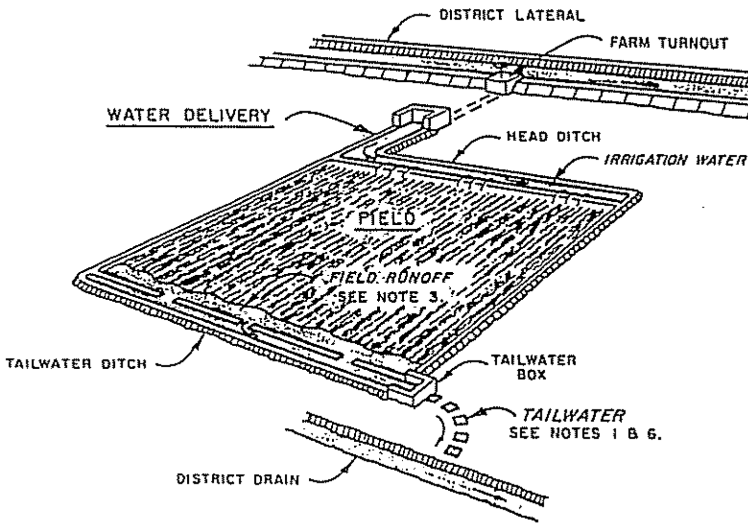
Tim O'Halloran

TIM F. O'HALLORAN

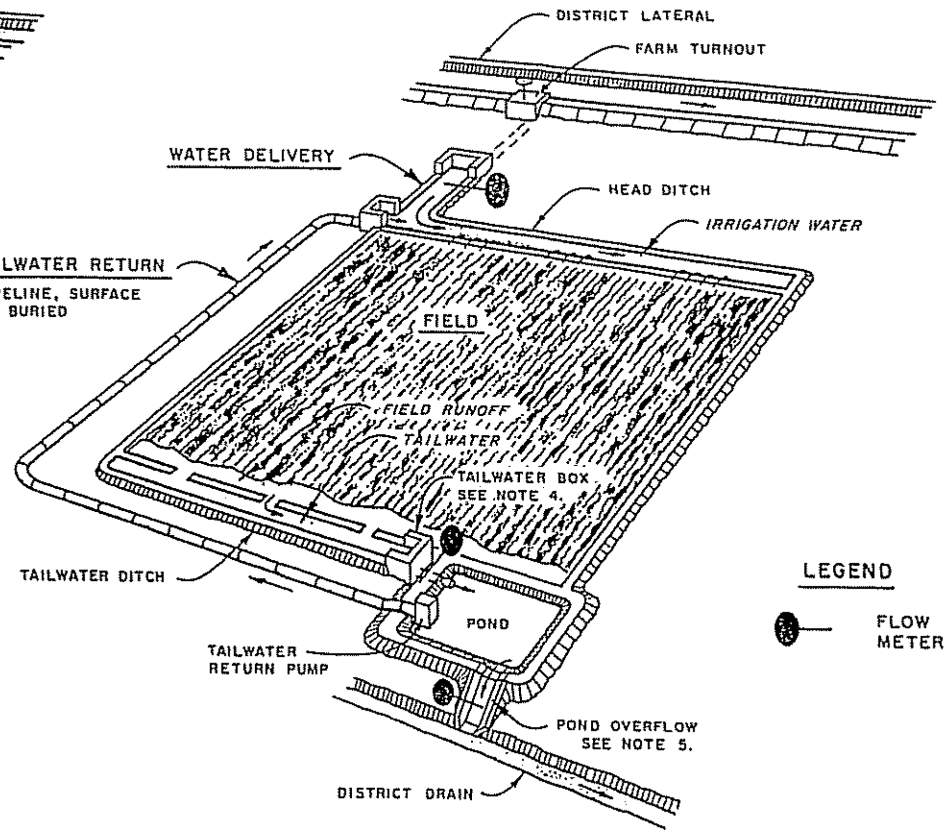
a:TIM:\TW%2

TFO:djb

FIGURE 13



EXISTING IRRIGATION



TAILWATER REUSE IRRIGATION

LEGEND

FLOW METER

NOTES

1. TAILWATER IS WATER ORDERED AND DELIVERED BUT NOT USED. IT CONSISTS OF FIELD RUNOFF.
2. WATER IS WASTED WHEN IRRIGATION IS COMPLETED BEFORE DELIVERY ENDS.
3. SOME TAILWATER FROM FIELD RUNOFF IS UNAVOIDABLE.
4. TAILWATER FLOWS INTO HOLDING POND INSTEAD OF INTO DISTRICT DRAIN.
5. TAILWATER REUSE SYSTEM (POND, PUMP, AND RETURN PIPELINE) REDUCES AMOUNT OF TAILWATER FLOW INTO DISTRICT DRAIN.
6. APPROXIMATELY 16% OF WATER NOW DELIVERED IN IMPERIAL IRRIGATION DISTRICT RUNS OFF AS TAILWATER.

IRRIGATION WATER MANAGEMENT

TAILWATER RETURN DIAGRAM

PROJECT 18

BOOKMAN-EDMONSTON ENGINEERING, INC.

FEBRUARY 1991

21-4

WIS Data Available

system wide

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
AAC Allison Check	ALLIA	97AAC___ALL_C	03/06/1997	04/30/2003
AAC Drop 1 Check AVM	DR1AA	97AAC____D1_V	01/16/1997	04/30/2003
AAC New River Siphon AVM	NRCHA	97AAC____NR_V	03/06/1997	04/30/2003
AAC d/s Central Main Check	CMCHA	97AAC____CM_C	02/25/1997	04/30/2003
AAC d/s East Highline Check AVM	EHCKA	97AAC___EHLCV	02/25/1997	04/30/2003
AAC to New River Spillway	NRSPA	97AAC____NR_S	07/31/1997	04/30/2003
Acacia Canal Heading BCW	ACIAA	97ACA_______H	04/21/1997	04/30/2003
Alamo River Drop 3	ARD3	19AR_____D3AR	05/09/1996	04/30/2003
Alamo River In	ALIN	97AR_____USMW	01/14/1997	04/30/2003
Alamo River Out AVM	ALOU	97AR_____SS_V	01/15/1997	04/30/2003
Alder Canal Heading BCW	ALDEA	97ALD_______H	04/21/1997	04/30/2003
B Drain	BSPLD	17B_____044_D	09/08/1994	10/17/1995
B Lateral Interface	BIFGA	17B_____032_I	01/31/1996	04/30/2003
B Lateral Spill	BSPLA	17B_____044_S	12/19/1993	04/30/2003
Bevins Reservoir Discharge	CBRESA	03BEVRES____R	01/01/1996	04/30/2003
Briar Discharge to Central Main Canal	BRISA	97BRI___007_I	03/06/1997	04/30/2003
C Drain	CSPLD	17C_____031_D	06/01/1994	10/04/1995
C Lateral Interface	CIFGA	17C_____031_I	01/31/1996	04/30/2003
C Lateral Spill	CSPLA	17C_____031_S	12/19/1993	04/30/2003
Carter Reservoir Discharge to WSM AVM	CARO	97CARRES____V	05/01/1997	04/30/2003
Central Main Emergency (Dahlia) Spill	DHSP	97CM___ELDH_S	08/06/1997	04/30/2003
Central Main Heading at Briar Siphon	CMTOA	97CM____AAC_H	03/06/1997	04/30/2003
Central Main IG to Fudge Reservoir	FUDI	97CM____FUD_I	12/01/2001	12/17/2001
Coachella Canal Heading	COAC	97COA_______H	01/16/1997	04/30/2003
Coachella Heading Flume	COAH	97COA___AAC_F	05/12/1998	04/30/2003
D Drain	DDRN	17D_________D	05/03/1994	10/17/1995
D Lateral Interface	DIFGA	17D_____031_I	01/31/1996	04/30/2003
D Lateral Spill	DSPLA	17D_____031_S	12/19/1993	04/30/2003
Daffodil Canal Heading BCW	DAFF	19DAF_______H	08/08/1996	04/30/2003
Daffodil Canal Spill	DAFFS	19DAF___020_S	08/08/1996	04/30/2003
E Drain	EDRN	17E_________D	05/03/1994	10/17/1995

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
EHL Canal d/s Nectarine Check	NECTA	97EHL___NEC_C	08/14/1997	04/30/2003
East Highline Canal Drop 16	HL16	19EHL___016_W	05/29/1996	04/30/2003
East Highline Canal Spill to Z Spill	ZSPLA	04GALRES_EHLS	01/23/1995	04/30/2003
East Highline Heading AVM	EHTOA	97EHL___AAC_H	08/11/1997	04/30/2003
East Highline IG to Galleano Reservoir	GALI	97EHL___GAL_I	06/02/1997	04/30/2003
East Highline IG to Singh Reservoir	SINI	97EHL___SIN_I	06/03/1997	04/30/2003
East Highline Side Main Heading BCW	EHSMA	97HLS_______H	04/24/1997	04/30/2003
Ebony Canal Heading BCW	EBOY	19EBO_______H	08/08/1996	04/30/2003
Ebony Canal Spill	EBOYS	19EBO___014_S	08/08/1996	04/30/2003
Elder Canal Heading BCW	ELDH	19ELD_______H	03/15/1996	04/30/2003
Elder Canal Spill	ELDCA	19ELD___129_S	01/01/1997	04/30/2003
Elder Lateral 13 Spill	EL13S	19ELD13_099_S	01/01/1997	04/30/2003
Elm Canal Spill	ELMSA	19ELM___054_S	01/01/1997	04/30/2003
Elm Lateral 3 Spill	ELM3S	19ELM3__029_S	01/28/1997	04/30/2003
Eucalyptus Canal Heading BCW	EUCH	97EUC____CM_H	08/07/1997	04/30/2003
Fillaree Canal Spill	104	19FIL___030_S	10/05/1999	04/30/2003
Galleano Reservoir Discharge to EHL	GALO	97GALRESEHL_R	06/02/1997	04/30/2003
Hemlock Canal Heading	HEM	97HEM_______H	01/23/2003	04/30/2003
Hemlock Lateral Heading BCW	HEMH	97HEM_______H	01/22/2003	04/30/2003
Holt Canal Heading	HOLT	97HOL_______H	01/23/2003	04/30/2003
Holtville Drain 1 to Holtville Main Dr	HVHMD	03HV1___018_D	05/22/1993	07/12/1995
Malva Drain	MLV2D	17ML2_______D	04/30/1994	10/17/1995
Malva Lateral 2 Interface	MLV2IA	17ML2___019_I	01/31/1996	04/30/2003
Malva Lateral 2 Spill	MLV2A	17ML2___020_S	12/19/1993	04/30/2003
Marigold Drain	MG26ADRN	17MAR___026_D	05/28/1994	04/30/2003
Marigold Lateral Interface	MARIA	17MAR___023_I	01/31/1996	04/30/2003
Marigold Lateral Spill at Delivery 24	MG24A	17MAR___024_S	12/19/1993	04/30/2003
Marigold Lateral Spill at Delivery 26	MG26A	17MAR___026_S	12/21/1993	04/30/2003
Mayflower Drain	MFLWADRN	17MAY___022_D	06/02/1994	04/30/2003
Mayflower Lateral Heading BCW	MFLHA	17MAY_______H	04/16/1994	04/30/2003
Mayflower Lateral Interface	MAYIA	17MAY___020AI	01/31/1996	04/30/2003

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Mayflower Lateral Spill	MFLWA	17MAY___022_S	12/19/1993	04/30/2003
Mul-D Interceptor North SCW d/s B Lat IG	MDIW3A	17MDI___BIG_W	05/09/1996	04/30/2003
Mul-D Interceptor South BCW d/s Nut IG	MDIW2A	17MDI_NUTIG_W	01/31/1996	04/30/2003
Mul-D Interceptor South BCW d/s Std IG	MDIW1A	17MDI_STDIG_W	02/12/1996	01/06/1997
Mulberry Drain	MULSD	17MUL___022_D	06/25/1994	10/17/1995
Mulberry Lateral Heading BCW	MULHA	17MUL_______H	07/07/1993	04/30/2003
Mulberry Lateral Interface	MULIA	17MUL___020_I	01/31/1996	04/30/2003
Mulberry Lateral Spill	MULSA	17MUL___022_S	07/07/1993	04/30/2003
Munyon Lateral Spill	112	19MUN___029_S	09/15/1998	04/30/2003
Myrtle Lateral Heading BCW	MYRH	19MYR___EHL_H	05/26/1999	04/30/2003
Myrtle Lateral Spill	111	19MYR___028_S	09/15/1998	04/30/2003
Narcissus Drain	NARSADRN	17NAR___023_D	06/10/1994	04/30/2003
Narcissus Lateral Interface	NARIA	17NAR___019_I	01/31/1996	04/30/2003
Narcissus Lateral Spill	NARSA	17NAR___023_S	07/07/1993	04/30/2003
Narcisuss Lateral Heading BCW	NARHA	17NAR_______H	07/07/1993	03/13/1994
Nectarine Drain	NECDA	17NEC_______D	04/30/1994	10/17/1995
Nettle Drain	NTTLD	17NET___019_D	07/21/1994	10/17/1995
Nettle Lateral Interface	NETIA	17NET___016AI	01/31/1996	04/30/2003
Nettle Lateral Spill	NTTLA	17NET___019_S	12/19/1993	04/30/2003
New River In	NRIN	97NR_____USMG	01/15/1997	04/30/2003
New River Out	NROU	97NR_____SS_G	01/15/1997	04/30/2003
Niland Extension Heading BCW	NDXH	19NDX_______H	02/20/1996	04/30/2003
Nutmeg Drain	NUTDA	17NUT_______D	04/30/1994	10/17/1995
Nutmeg Lateral Interface	NUTIA	17NUT___017AI	01/31/1996	04/30/2003
Oasis Drain to Alamo River	OASSD	03OAS___034_D	12/17/1993	07/12/1995
Oasis Drain to Holtville Drain 8	OAH8D	03OAS___024AD	05/14/1993	07/12/1995
Oasis Drain to Holtville Main Drain	OAHMD	03OAS___020_D	06/08/1993	07/12/1995
Oasis Lateral Interface	OASIA	03OAS___034_I	06/11/1993	04/30/2003
Oasis Lateral Spill	OASSA	03OAS___034_S	01/22/1993	04/30/2003
Oat Drain to Alamo River	OATSD	03OAT___031_D	12/16/1993	07/12/1995
Oat Drain to Holtville Drain 8	OTH8D	03OAT___023_D	05/14/1993	07/12/1995

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Oat Drain to Holtville Main Drain	OTHMD	03OAT___020_D	05/14/1993	07/12/1995
Oat Lateral Interface	OATIA	03OAT___031_I	06/11/1993	04/30/2003
Oat Lateral Spill	OATSA	03OAT___031_S	01/22/1993	04/30/2003
Olive Lateral Spill	110	19OLI___029_S	09/15/1998	04/30/2003
Orange Lateral Heading BCW	ORNGA	15ORA_______H	07/19/1994	04/30/2003
Orange Lateral Spill	ORASA	15ORA___035_S	10/31/1994	04/30/2003
Orchid Lateral Spill	109	19ORC___044_S	12/04/2000	04/30/2003
Orient Drain to Alamo River	ORARD	03ORI___031_D	05/18/1993	07/12/1995
Orient Drain to Holtville Main Drain	ORHMD	03ORI___020_D	05/14/1993	07/12/1995
Orient Lateral Spill	ORSPA	03ORI___031_S	05/18/1993	07/12/1995
Palm Drain to Alamo River	PLMSD	03PLM___036_D	12/17/1993	07/12/1995
Palm Lateral Interface	PLMIA	03PLM___036_I	06/11/1993	04/30/2003
Palm Lateral Spill	PLMSA	03PLM___036_S	01/22/1993	04/30/2003
Pepper Drain to Alamo River	PEPDD	03PEP___036_D	03/19/1994	07/12/1995
Pepper Drain to Holtville Main Drain	PEHMD	03PEP___020_D	05/22/1993	07/12/1995
Pepper Lateral Check 36 (Interceptor)	PEPCA	03PEP___036_C	03/19/1994	04/30/2003
Pepper Lateral Interface	PEPIA	03PEP___033_I	06/11/1993	04/30/2003
Pepper Lateral Spill	PEPSA	03PEP___033_S	01/22/1993	04/30/2003
Pine Drain to Alamo River	PINSD	03PIN___033_D	06/08/1993	07/12/1995
Pine Drain to Holtville Drain 4	PNH4D	03PIN___020_D	05/14/1993	07/12/1995
Pine Drain to Holtville Drain 8	PNH8D	03PIN___023_D	05/14/1993	07/12/1995
Pine Drain to Holtville Main Drain	PNHMD	03PIN___008_D	05/22/1993	07/12/1995
Pine Lateral Interface	PINIA	03PIN___033_I	06/11/1993	04/30/2003
Pine Lateral Spill	PINSA	03PIN___033_S	01/30/1993	04/30/2003
Plum Lateral Interface	PLUIA	03PLU___036_I	06/11/1993	04/30/2003
Plum Lateral Spill	PLUSA	03PLU___036_S	01/22/1993	04/30/2003
Plum-Oasis Interceptor BCW at Bevins R	POIWA	03BEVRES_POIW	08/26/1994	04/30/2003
Plum-Oasis Interceptor Spill	POSPA	03POI_______S	04/02/1993	04/30/2003
Pomelo 1 Spill at Delivery 35	POMSA	03POM___035_S	01/22/1993	04/30/2003
Pomelo 2 Spill at Delivery 39	PO39A	03POM___039_S	01/22/1993	04/30/2003
Pomelo Drain to Alamo River	PO39D	03POM___039_D	06/08/1993	07/12/1995

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Pomelo Drain to Holtville Main Drain	POHMD	03POM___018_D	05/14/1993	07/12/1995
Pomelo Lateral Interface	POMIA	03POM___035_I	06/11/1993	04/30/2003
R Lateral Spill	136	19R_____024_S	12/01/2000	04/30/2003
Redwood Canal Heading BCW	REDHA	03RED_______H	03/10/1995	04/30/2003
Redwood Canal Spill	REDSA	03RED___096_S	07/06/1995	04/30/2003
Redwood Lateral 5 Spill	RED5S	19RED5__076_S	03/12/1997	04/30/2003
Redwood Lateral 8 Spill	RED8S	19RED8__088_S	01/30/1997	04/30/2003
Rockwood Discharge to Vail Supply Canal	RWSP	17RW____173AI	04/11/1996	04/30/2003
Rose Canal Heading BCW	ROSEA	97ROS_______H	04/21/1997	04/30/2003
Rositas Canal IG to Sperber Reservoir	SPEI	97RST___SPE_I	05/01/1997	04/30/2003
Rositas Canal Spill	ROSPA	97RST___005_S	05/02/1997	04/30/2003
Rositas Supply Canal Heading BCW	RSTH	19RST_______H	03/15/1996	04/30/2003
Rubber Heading BCW	RBBRA	97RUB_______H	04/21/1997	04/30/2003
Russell Reservoir Discharge AVM	RUSR	17RUSRES____R	04/11/1997	04/30/2003
Singh Reservoir Discharge to EHL Canal	SPMP	09SINRES_EHLR	01/27/1999	04/30/2003
Singh Reservoir Discharge to Vail Supply	SINO	97SINRESVS__R	05/29/1997	04/30/2003
South Alamo Canal Heading	SOAH	97SOA___AAC_H	08/14/1997	04/30/2003
Sperber Reservoir Discharge to Rose C	SPE01	97SPERESROS_R	05/01/1997	04/30/2003
Sperber Reservoir Discharge to Rubber C	SPE02	97SPERESRUB_R	05/01/1997	04/30/2003
Spruce Canal Interface	SPUI	08SPU___032_I	12/04/1997	04/30/2003
Spruce Canal Spill	SPSPA	08SP____036AS	01/24/1995	04/30/2003
Spruce Lateral 5 Spill	SP5SA	08SP5___087BS	01/18/1995	04/30/2003
Spruce Lateral 6 Interface	SP6I	08SP6___100_I	12/19/1997	04/30/2003
Spruce Lateral 6 Spill	SP6SA	08SP6___100AS	01/18/1995	04/30/2003
Standard Drain	STDDA	17STD_______D	05/04/1994	04/30/2003
Standard Lateral Heading SCW	STDHA	17STD_______H	07/07/1993	04/30/2003
Standard Lateral Interface	STDIA	17STD___018_I	01/31/1996	04/30/2003
Standard Lateral Spill	STDSA	17STD___019_S	07/07/1993	04/30/2003
Tamarack Lateral Interface	TMKI	08TAM___224_I	12/22/1997	04/30/2003
Timothy Lateral Interface	TIMI	08TIM___212_I	01/20/1998	04/30/2003
Township Drain to Alamo River	TOWSD	03TOW___030_D	06/08/1993	07/12/1995

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Township Drain to Holtville Drain 8	TWH8D	03TOW___023_D	06/07/1993	07/12/1995
Township Drain to Holtville Main Drain	TWHMD	03TOW___020_D	05/22/1993	07/12/1995
Township Lateral Interface	TOWIA	03TOW___030_I	06/11/1993	04/30/2003
Township Lateral Spill	TOWSA	03TOW___030_S	02/05/1993	04/30/2003
Trifolium Interceptor BCW at Willey Res	TRIW	08TRI___RES_W	12/22/1997	04/30/2003
Trifolium Interceptor Spill	TRSP	08TRI___RES_S	12/22/1997	04/30/2003
Trifolium Lateral 10 Interface	TR10I	08T10___200_I	12/22/1997	04/30/2003
Trifolium Lateral 11 Interface	TR11I	08T11___220_I	01/01/1998	04/30/2003
Trifolium Lateral 11 Spill	T11SA	08T11___220ES	02/08/1995	04/30/2003
Trifolium Lateral 12 Heading BCW	T12HA	15T12_______H	05/13/1994	04/30/2003
Trifolium Lateral 12 Interface	TR12I	08T12___232_I	01/20/1998	04/30/2003
Trifolium Lateral 12 Spill	T12S	15T12___237_S	03/01/1996	04/30/2003
Trifolium Lateral 12 Spill (94/95)	T12SA	15T12___238_S	03/04/1994	09/17/1995
Trifolium Lateral 13 Heading BCW	LT13A	15T13_______H	02/01/1994	04/30/2003
Trifolium Lateral 13 Spill	T13SA	15T13___259_S	03/04/1994	04/30/2003
Trifolium Lateral 2 Interface	TR02I	08T2____036_I	01/13/1998	04/30/2003
Trifolium Lateral 2 Spill	T02S	08T2____036_S	01/17/1996	04/30/2003
Trifolium Lateral 2 Spill (1995)	T02SA	08T2____038_S	01/18/1995	01/16/1996
Trifolium Lateral 3 Interface	TR03I	08T3____055_I	12/22/1997	04/30/2003
Trifolium Lateral 4 Interface	TR04I	08T4____079_I	12/22/1997	04/30/2003
Trifolium Lateral 4 Spill	T04SA	08T4____079_S	01/18/1995	04/30/2003
Trifolium Lateral 5 Interface	TR05I	08T5____098AI	12/22/1997	04/30/2003
Trifolium Lateral 6 Interface	TR06I	08T6____118_I	04/09/1998	04/30/2003
Trifolium Lateral 7 Interface	TR07I	08T7____137_I	12/22/1997	04/30/2003
Trifolium Lateral 7 Spill	T07SA	15T7____140AS	01/15/1994	04/30/2003
Trifolium Lateral 8 Heading BCW	T08HA	15T8________H	07/13/1994	04/30/2003
Trifolium Lateral 8 Interface	TR08I	08T8____155_I	12/22/1997	04/30/2003
Trifolium Lateral 8 Spill	T08SA	15T8____160_S	10/31/1994	04/30/2003
Trifolium Lateral 9 Heading BCW	T09HA	15T9________H	05/13/1994	04/30/2003
Trifolium Lateral 9 Interface	TR09I	08T9____180FI	01/01/1998	04/30/2003
Trifolium Lateral 9 Spill	T09SA	15T9____180ES	03/03/1994	04/24/1997

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Vail Canal Heading	VMHA	97VM_____VS_H	08/11/1997	04/30/2003
Vail Canal IG to Willey Reservoir	VMI	08VM____701_I	12/22/1997	04/30/2003
Vail Canal Spill	VMSPA	17VM____701_S	12/19/1993	04/30/2003
Vail Lateral 4 IG to Kate's Lake	VLAT4	97V4____409_I	09/28/2000	**04/15/2003**
Vail Lateral 6 Spill	154	19V6____612_S	10/21/1998	04/30/2003
Vail Supply Canal Drop 41	VS41	17VS____041_W	05/09/1996	04/30/2003
Vail Supply Canal Heading Drop 0	VS0H	97VS____000_H	10/03/1997	04/30/2003
Vail Supply Canal Heading Drop 2	VS2H	19VS____002_H	03/13/1996	04/30/2003
Vail Supply Canal IG to Russell Res	RUSI	17VS__RUSRESI	03/13/1997	04/30/2003
Vail Supply Canal IG to Young Reservoir	MDRI	17VS____040AI	05/07/1996	04/30/2003
Vail Supply Canal Spill at North End Dam	VNEDA	17VM____NED_S	07/02/1994	04/30/2003
Walnut Lateral Heading	WNUT	97WAL_______H	01/23/2003	**02/10/2003**
Westside Main Canal Heading at Weir 1	WSMH	97WSM___AAC_H	08/11/1997	04/30/2003
Westside Main Canal Sp to Trif Storm Dr	WSMSA	01WSM___100_S	07/06/1995	04/30/2003
Westside Main Dixie 6 Spill	DX06A	97WSM___DIX6S	08/06/1997	04/30/2003
Westside Main Dixie Spill	DXSP	97WSM___DIX_S	02/01/2001	04/30/2003
Westside Main IG to Carter Reservoir	CARI	97WSM___CAR_I	05/01/1997	04/30/2003
Willey Reservoir Discharge	TRES	08TRIRES____R	02/17/1998	04/30/2003
Wisteria Canal Heading	WIST	97WST_______H	01/23/2003	04/30/2003
Woodbine Heading	WBIN	97WB________H	11/05/2002	04/30/2003
Woodbine Lateral 2 Heading	WBL2	97WB2_______H	11/06/2002	04/30/2003
Woodbine Lateral 3 Heading	WBL3	97WB3_______H	11/06/2002	04/30/2003
Wormwood Canal Heading	WWOD	97WW________H	01/23/2003	04/30/2003
Wormwood Canal Spill	183	19WW____088_S	01/24/2001	04/30/2003
Wormwood Lateral Heading BCW	WWODH	97WW________H	01/22/2003	04/30/2003
Young Reservoir Discharge	MUDR	17MDRES_____R	05/09/1996	04/30/2003

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current

Easylogger Site Name Everything starting 01/01/96 was always a logger. All else was Stevens Recorder data and is hydrographer daily values.	Rep Name	Site Code	From Date	To Date
AAC Drain 1 Drop 3	101	98AAC1AACD3_D	01/01/1996	11/30/2000
Alamo River Drop 9	166	98AR_____D9_W	01/01/1996	03/31/2003
Ash Lateral 30 Spill	102	98ASH30_212_S	01/01/1996	03/31/2003
Ash Lateral 45 Spill	170	98ASH45_191AS	01/01/1988	03/31/2003
Ash Lateral 6 Spill	171	98ASH6__045BS	01/01/1988	03/31/2003
Central Drain Drop 2	158	98CD___CDD2_D	01/01/1996	03/31/2003
Daffodil Canal Spill (Logger)	172	98DAF___020_S	01/01/1988	08/07/1996
Dahlia Lateral Spill	105	98DAH___080_S	01/01/1996	03/31/2003
Dogwood Lateral 10	173	98DOG10_085AS	01/01/1988	03/31/2003
Dogwood Lateral 6	184	98DOG6__070_S	12/29/1999	12/31/2000
E Lateral Spill	130	98E_____052_S	01/01/1988	03/31/2003
East Highline Lateral 10 Spill	174	98L10___260_S	01/01/1988	03/31/2003
East Highline Lateral 14 Spill	175	98L14___309_S	01/01/1988	03/31/2003
Elder Canal Spill	ELDCA	19ELD___129_S	01/01/1982	12/31/1996
Elder Lateral 13 Spill	EL13S	19ELD13_099_S	07/01/1985	12/31/1996
Elm Canal Spill	ELMSA	19ELM___054_S	01/04/1982	12/31/1996
Elmore Lake	129	99EMRLK_SFW_S	01/01/1996	04/30/2003
Eucalyptus Lateral 10 Spill	108	98EUC10_102_S	01/01/1988	03/31/2003
Eucalyptus Lateral Spill	107	98EUC___155_S	01/01/1996	03/31/2003
Fig Drain	164	98FIG__NEWR_D	01/01/1996	03/31/2003
Fillaree Canal Spill	104	19FIL___030_S	01/01/1983	10/04/1999
Greeson Drain	162	98GRE__NEWR_D	01/01/1996	12/31/2002
Holt Lateral Spill	178	98HOL___128_S	01/01/1988	03/31/2003
Holtville Main Drain	160	98HOL____AR_D	01/01/1996	03/31/2003
Malva Lateral 1 Spill	994	17ML1___005_S	01/01/1988	05/10/1993
Marigold Lateral Spill at Delivery 24	MG24A	17MAR___024_S	01/01/1988	03/28/1993
Moorhead Lateral Spill	179	98MH____210_S	01/01/1988	03/31/2003
Moss Lateral Spill	180	98MOS___026_S	01/01/1988	03/31/2003
Munyon Lateral Spill	112	19MUN___029_S	02/24/1985	09/14/1998
Myrtle Lateral Heading BCW	MYRH	19MYR___EHL_H	12/13/1991	05/25/1999
Myrtle Lateral Spill	111	19MYR___028_S	02/14/1985	09/14/1998

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Easylogger Site Name Everything starting 01/01/96 was always a logger. All else was Stevens Recorder data and is hydrographer daily values.	Rep Name	Site Code	From Date	To Date
Nectarine Lat Spill to Vail Supply Canal	185	97NEC___007_S	02/17/2000	03/31/2003
Niland Drain 1	144	99ND1___DTS_D	01/01/1996	04/30/2003
Niland Drain 2	145	99ND2___DTS_D	01/01/1996	04/30/2003
Niland Drain 3	146	99ND3___DTS_D	01/01/1996	04/30/2003
Niland Drain 4	147	99ND4___DTS_D	01/01/1996	04/30/2003
Niland Drain 5	148	99ND5___DTS_D	01/01/1996	04/30/2003
Niland Lateral 2 Spill	999		01/01/1988	12/31/1990
O Drain	131	99O_____DTS_D	01/01/1996	04/30/2003
Oakley Lateral Spill	116	98OKY___100_S	01/01/1988	03/31/2003
Oasis Lateral Spill	OASSA	03OAS___034_S	01/01/1988	08/16/1992
Olive Lateral Spill	110	19OLI___029_S	01/05/1983	09/14/1998
Orchid Lateral Spill	109	19ORC___044_S	01/05/1983	12/03/2000
P Drain	133	99P_____DTS_D	01/01/1996	04/30/2003
P Lateral Spill	132	99P_____031_S	01/01/1996	04/30/2003
Pomelo 2 Spill at Delivery 39	PO39A	03POM___039_S	01/01/1988	10/18/1992
Q Drain	135	99Q_____DTS_D	01/01/1996	04/30/2003
Q Lateral Spill	134	99Q_____028_S	01/01/1996	04/30/2003
R Drain	137	99R_____DTS_D	01/01/1996	04/30/2003
R Lateral Spill	136	19R_____024_S	01/01/1982	11/30/2000
Redwood Canal Spill	REDSA	03RED___096_S	01/01/1982	12/14/1994
Rice 3 Drain	165	98RIC3_NEWR_D	01/01/1996	03/31/2003
Rice Drain	163	98RIC__NEWR_D	01/01/1996	03/31/2003
Rockwood Weir	113	98RW___CM16_W	01/01/1996	03/31/2003
Rose Drain Outlet	156	98ROS____AR_D	01/01/1996	03/31/2003
Rose Lateral Spill - Both Bays	103	98ROS___083_S	01/01/1982	12/31/1995
Rose Lateral Spill - Left Bay	167	98ROS___083yS	09/11/1996	03/31/2003
Rose Lateral Spill - Right Bay	168	98ROS___083zS	09/11/1996	03/31/2003
S Drain	139	99S_____DTS_D	01/01/1996	04/30/2003
S Lateral Spill	138	98S_____022_S	07/01/1985	03/31/2003
South Alamo Automatic Spill	181	98SOA___043_S	01/01/1996	03/31/2003
South Alamo Spill	182	98SOA___119_S	01/01/1996	03/31/2003

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Easylogger Site Name Everything starting 01/01/96 was always a logger. All else was Stevens Recorder data and is hydrographer daily values.	Rep Name	Site Code	From Date	To Date
South Central Drain Outlet	157	98SOC____AR_D	01/01/1996	03/31/2003
Spruce Lateral 3 Spill	119	98SP3___076_S	01/01/1988	03/31/2003
Stanley Lateral 1 Spill	115	98STL1__076_S	01/01/1988	03/31/2003
Sumac Lateral 1 Spill	117	98SUM1__027_S	01/01/1988	03/31/2003
T Drain	140	99T_____DTS_D	01/01/1996	04/30/2003
Trifolium 1 Drain	125	99T1____DTS_D	01/01/1996	04/30/2003
Trifolium 10 Drain	122	99T10__NEWR_D	01/01/1996	04/30/2003
Trifolium 11 Drain	123	99T11__NEWR_D	01/01/1996	04/30/2003
Trifolium 20 Drain	126	99T20___DTS_D	01/01/1996	04/30/2003
Trifolium 20A Drain	120	99T20A__DTS_D	01/01/1996	04/30/2003
Trifolium Lateral 5 Spill	121	98T5____099_S	07/01/1985	02/02/1999
Trifolium Lateral 9 Spill	T09SA	15T9____180ES	07/01/1985	06/30/1997
U Drain	141	99U_____DTS_D	01/01/1996	04/30/2003
Vail Lateral 4 Spill	149	98V4____422_S	01/01/1988	03/31/2003
Vail Lateral 4A Spill	150	99V4A___461_S	01/01/1996	04/30/2003
Vail Lateral 6 Spill	154	19V6____612_S	01/01/1982	10/20/1998
Verde Drain Outlet	159	98VRD____AR_D	01/01/1996	03/31/2003
W+Y Drain	142	99WY____DTS_D	01/01/1996	04/30/2003
Westside Main Canal Weir	118	98WSM___064_W	01/01/1996	03/31/2003
Wisteria Lateral 6A Spill	998		01/01/1988	05/01/1991
Wormwood Canal Spill	183	19WW____088_S	10/30/1985	01/23/2001
Z Drain	143	99Z_____DTS_D	01/01/1996	04/30/2003

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system wide

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
AAC Allison Check	ALLIA	97AAC___ALL_C	03/06/1997	04/30/2003
AAC Drop 1 Check AVM	DR1AA	97AAC____D1_V	01/16/1997	04/30/2003
AAC New River Siphon AVM	NRCHA	97AAC____NR_V	03/06/1997	04/30/2003
AAC d/s Central Main Check	CMCHA	97AAC____CM_C	02/25/1997	04/30/2003
AAC d/s East Highline Check AVM	EHCKA	97AAC___EHLCV	02/25/1997	04/30/2003
AAC to New River Spillway	NRSPA	97AAC____NR_S	07/31/1997	04/30/2003
Acacia Canal Heading BCW	ACIAA	97ACA_______H	04/21/1997	04/30/2003
Alamo River Drop 3	ARD3	19AR_____D3AR	05/09/1996	04/30/2003
Alamo River In	ALIN	97AR_____USMW	01/14/1997	04/30/2003
Alamo River Out AVM	ALOU	97AR_____SS_V	01/15/1997	04/30/2003
Alder Canal Heading BCW	ALDEA	97ALD_______H	04/21/1997	04/30/2003
B Drain	BSPLD	17B_____044_D	09/08/1994	10/17/1995
B Lateral Interface	BIFGA	17B_____032_I	01/31/1996	04/30/2003
B Lateral Spill	BSPLA	17B_____044_S	12/19/1993	04/30/2003
Bevins Reservoir Discharge	CBRESA	03BEVRES____R	01/01/1996	04/30/2003
Briar Discharge to Central Main Canal	BRISA	97BRI___007_I	03/06/1997	04/30/2003
C Drain	CSPLD	17C_____031_D	06/01/1994	10/04/1995
C Lateral Interface	CIFGA	17C_____031_I	01/31/1996	04/30/2003
C Lateral Spill	CSPLA	17C_____031_S	12/19/1993	04/30/2003
Carter Reservoir Discharge to WSM AVM	CARO	97CARRES____V	05/01/1997	04/30/2003
Central Main Emergency (Dahlia) Spill	DHSP	97CM___ELDH_S	08/06/1997	04/30/2003
Central Main Heading at Briar Siphon	CMTOA	97CM____AAC_H	03/06/1997	04/30/2003
Central Main IG to Fudge Reservoir	FUDI	97CM____FUD_I	12/01/2001	12/17/2001
Coachella Canal Heading	COAC	97COA_______H	01/16/1997	04/30/2003
Coachella Heading Flume	COAH	97COA___AAC_F	05/12/1998	04/30/2003
D Drain	DDRN	17D_________D	05/03/1994	10/17/1995
D Lateral Interface	DIFGA	17D_____031_I	01/31/1996	04/30/2003
D Lateral Spill	DSPLA	17D_____031_S	12/19/1993	04/30/2003
Daffodil Canal Heading BCW	DAFF	19DAF_______H	08/08/1996	04/30/2003
Daffodil Canal Spill	DAFFS	19DAF___020_S	08/08/1996	04/30/2003
E Drain	EDRN	17E_________D	05/03/1994	10/17/1995

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RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
EHL Canal d/s Nectarine Check	NECTA	97EHL___NEC_C	08/14/1997	04/30/2003
East Highline Canal Drop 16	HL16	19EHL___016_W	05/29/1996	04/30/2003
East Highline Canal Spill to Z Spill	ZSPLA	04GALRES_EHLS	01/23/1995	04/30/2003
East Highline Heading AVM	EHTOA	97EHL___AAC_H	08/11/1997	04/30/2003
East Highline IG to Galleano Reservoir	GALI	97EHL___GAL_I	06/02/1997	04/30/2003
East Highline IG to Singh Reservoir	SINI	97EHL___SIN_I	06/03/1997	04/30/2003
East Highline Side Main Heading BCW	EHSMA	97HLS_______H	04/24/1997	04/30/2003
Ebony Canal Heading BCW	EBOY	19EBO_______H	08/08/1996	04/30/2003
Ebony Canal Spill	EBOYS	19EBO___014_S	08/08/1996	04/30/2003
Elder Canal Heading BCW	ELDH	19ELD_______H	03/15/1996	04/30/2003
Elder Canal Spill	ELDCA	19ELD___129_S	01/01/1997	04/30/2003
Elder Lateral 13 Spill	EL13S	19ELD13_099_S	01/01/1997	04/30/2003
Elm Canal Spill	ELMSA	19ELM___054_S	01/01/1997	04/30/2003
Elm Lateral 3 Spill	ELM3S	19ELM3__029_S	01/28/1997	04/30/2003
Eucalyptus Canal Heading BCW	EUCH	97EUC____CM_H	08/07/1997	04/30/2003
Fillaree Canal Spill	104	19FIL___030_S	10/05/1999	04/30/2003
Galleano Reservoir Discharge to EHL	GALO	97GALRESEHL_R	06/02/1997	04/30/2003
Hemlock Canal Heading	HEM	97HEM_______H	01/23/2003	04/30/2003
Hemlock Lateral Heading BCW	HEMH	97HEM_______H	01/22/2003	04/30/2003
Holt Canal Heading	HOLT	97HOL_______H	01/23/2003	04/30/2003
Holtville Drain 1 to Holtville Main Dr	HVHMD	03HV1___018_D	05/22/1993	07/12/1995
Malva Drain	MLV2D	17ML2_______D	04/30/1994	10/17/1995
Malva Lateral 2 Interface	MLV2IA	17ML2___019_I	01/31/1996	04/30/2003
Malva Lateral 2 Spill	MLV2A	17ML2___020_S	12/19/1993	04/30/2003
Marigold Drain	MG26ADRN	17MAR___026_D	05/28/1994	04/30/2003
Marigold Lateral Interface	MARIA	17MAR___023_I	01/31/1996	04/30/2003
Marigold Lateral Spill at Delivery 24	MG24A	17MAR___024_S	12/19/1993	04/30/2003
Marigold Lateral Spill at Delivery 26	MG26A	17MAR___026_S	12/21/1993	04/30/2003
Mayflower Drain	MFLWADRN	17MAY___022_D	06/02/1994	04/30/2003
Mayflower Lateral Heading BCW	MFLHA	17MAY_______H	04/16/1994	04/30/2003
Mayflower Lateral Interface	MAYIA	17MAY___020AI	01/31/1996	04/30/2003

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RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Mayflower Lateral Spill	MFLWA	17MAY___022_S	12/19/1993	04/30/2003
Mul-D Interceptor North SCW d/s B Lat IG	MDIW3A	17MDI___BIG_W	05/09/1996	04/30/2003
Mul-D Interceptor South BCW d/s Nut IG	MDIW2A	17MDI_NUTIG_W	01/31/1996	04/30/2003
Mul-D Interceptor South BCW d/s Std IG	MDIW1A	17MDI_STDIG_W	02/12/1996	01/06/1997
Mulberry Drain	MULSD	17MUL___022_D	06/25/1994	10/17/1995
Mulberry Lateral Heading BCW	MULHA	17MUL_______H	07/07/1993	04/30/2003
Mulberry Lateral Interface	MULIA	17MUL___020_I	01/31/1996	04/30/2003
Mulberry Lateral Spill	MULSA	17MUL___022_S	07/07/1993	04/30/2003
Munyon Lateral Spill	112	19MUN___029_S	09/15/1998	04/30/2003
Myrtle Lateral Heading BCW	MYRH	19MYR___EHL_H	05/26/1999	04/30/2003
Myrtle Lateral Spill	111	19MYR___028_S	09/15/1998	04/30/2003
Narcissus Drain	NARSADRN	17NAR___023_D	06/10/1994	04/30/2003
Narcissus Lateral Interface	NARIA	17NAR___019_I	01/31/1996	04/30/2003
Narcissus Lateral Spill	NARSA	17NAR___023_S	07/07/1993	04/30/2003
Narcisuss Lateral Heading BCW	NARHA	17NAR_______H	07/07/1993	03/13/1994
Nectarine Drain	NECDA	17NEC_______D	04/30/1994	10/17/1995
Nettle Drain	NTTLD	17NET___019_D	07/21/1994	10/17/1995
Nettle Lateral Interface	NETIA	17NET___016AI	01/31/1996	04/30/2003
Nettle Lateral Spill	NTTLA	17NET___019_S	12/19/1993	04/30/2003
New River In	NRIN	97NR_____USMG	01/15/1997	04/30/2003
New River Out	NROU	97NR_____SS_G	01/15/1997	04/30/2003
Niland Extension Heading BCW	NDXH	19NDX_______H	02/20/1996	04/30/2003
Nutmeg Drain	NUTDA	17NUT_______D	04/30/1994	10/17/1995
Nutmeg Lateral Interface	NUTIA	17NUT___017AI	01/31/1996	04/30/2003
Oasis Drain to Alamo River	OASSD	03OAS___034_D	12/17/1993	07/12/1995
Oasis Drain to Holtville Drain 8	OAH8D	03OAS___024AD	05/14/1993	07/12/1995
Oasis Drain to Holtville Main Drain	OAHMD	03OAS___020_D	06/08/1993	07/12/1995
Oasis Lateral Interface	OASIA	03OAS___034_I	06/11/1993	04/30/2003
Oasis Lateral Spill	OASSA	03OAS___034_S	01/22/1993	04/30/2003
Oat Drain to Alamo River	OATSD	03OAT___031_D	12/16/1993	07/12/1995
Oat Drain to Holtville Drain 8	OTH8D	03OAT___023_D	05/14/1993	07/12/1995

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RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Oat Drain to Holtville Main Drain	OTHMD	03OAT___020_D	05/14/1993	07/12/1995
Oat Lateral Interface	OATIA	03OAT___031_I	06/11/1993	04/30/2003
Oat Lateral Spill	OATSA	03OAT___031_S	01/22/1993	04/30/2003
Olive Lateral Spill	110	19OLI___029_S	09/15/1998	04/30/2003
Orange Lateral Heading BCW	ORNGA	15ORA_______H	07/19/1994	04/30/2003
Orange Lateral Spill	ORASA	15ORA___035_S	10/31/1994	04/30/2003
Orchid Lateral Spill	109	19ORC___044_S	12/04/2000	04/30/2003
Orient Drain to Alamo River	ORARD	03ORI___031_D	05/18/1993	07/12/1995
Orient Drain to Holtville Main Drain	ORHMD	03ORI___020_D	05/14/1993	07/12/1995
Orient Lateral Spill	ORSPA	03ORI___031_S	05/18/1993	07/12/1995
Palm Drain to Alamo River	PLMSD	03PLM___036_D	12/17/1993	07/12/1995
Palm Lateral Interface	PLMIA	03PLM___036_I	06/11/1993	04/30/2003
Palm Lateral Spill	PLMSA	03PLM___036_S	01/22/1993	04/30/2003
Pepper Drain to Alamo River	PEPDD	03PEP___036_D	03/19/1994	07/12/1995
Pepper Drain to Holtville Main Drain	PEHMD	03PEP___020_D	05/22/1993	07/12/1995
Pepper Lateral Check 36 (Interceptor)	PEPCA	03PEP___036_C	03/19/1994	04/30/2003
Pepper Lateral Interface	PEPIA	03PEP___033_I	06/11/1993	04/30/2003
Pepper Lateral Spill	PEPSA	03PEP___033_S	01/22/1993	04/30/2003
Pine Drain to Alamo River	PINSD	03PIN___033_D	06/08/1993	07/12/1995
Pine Drain to Holtville Drain 4	PNH4D	03PIN___020_D	05/14/1993	07/12/1995
Pine Drain to Holtville Drain 8	PNH8D	03PIN___023_D	05/14/1993	07/12/1995
Pine Drain to Holtville Main Drain	PNHMD	03PIN___008_D	05/22/1993	07/12/1995
Pine Lateral Interface	PINIA	03PIN___033_I	06/11/1993	04/30/2003
Pine Lateral Spill	PINSA	03PIN___033_S	01/30/1993	04/30/2003
Plum Lateral Interface	PLUIA	03PLU___036_I	06/11/1993	04/30/2003
Plum Lateral Spill	PLUSA	03PLU___036_S	01/22/1993	04/30/2003
Plum-Oasis Interceptor BCW at Bevins R	POIWA	03BEVRES_POIW	08/26/1994	04/30/2003
Plum-Oasis Interceptor Spill	POSPA	03POI_______S	04/02/1993	04/30/2003
Pomelo 1 Spill at Delivery 35	POMSA	03POM___035_S	01/22/1993	04/30/2003
Pomelo 2 Spill at Delivery 39	PO39A	03POM___039_S	01/22/1993	04/30/2003
Pomelo Drain to Alamo River	PO39D	03POM___039_D	06/08/1993	07/12/1995

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RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Pomelo Drain to Holtville Main Drain	POHMD	03POM___018_D	05/14/1993	07/12/1995
Pomelo Lateral Interface	POMIA	03POM___035_I	06/11/1993	04/30/2003
R Lateral Spill	136	19R_____024_S	12/01/2000	04/30/2003
Redwood Canal Heading BCW	REDHA	03RED_______H	03/10/1995	04/30/2003
Redwood Canal Spill	REDSA	03RED___096_S	07/06/1995	04/30/2003
Redwood Lateral 5 Spill	RED5S	19RED5__076_S	03/12/1997	04/30/2003
Redwood Lateral 8 Spill	RED8S	19RED8__088_S	01/30/1997	04/30/2003
Rockwood Discharge to Vail Supply Canal	RWSP	17RW____173AI	04/11/1996	04/30/2003
Rose Canal Heading BCW	ROSEA	97ROS_______H	04/21/1997	04/30/2003
Rositas Canal IG to Sperber Reservoir	SPEI	97RST___SPE_I	05/01/1997	04/30/2003
Rositas Canal Spill	ROSPA	97RST___005_S	05/02/1997	04/30/2003
Rositas Supply Canal Heading BCW	RSTH	19RST_______H	03/15/1996	04/30/2003
Rubber Heading BCW	RBBRA	97RUB_______H	04/21/1997	04/30/2003
Russell Reservoir Discharge AVM	RUSR	17RUSRES____R	04/11/1997	04/30/2003
Singh Reservoir Discharge to EHL Canal	SPMP	09SINRES_EHLR	01/27/1999	04/30/2003
Singh Reservoir Discharge to Vail Supply	SINO	97SINRESVS__R	05/29/1997	04/30/2003
South Alamo Canal Heading	SOAH	97SOA___AAC_H	08/14/1997	04/30/2003
Sperber Reservoir Discharge to Rose C	SPE01	97SPERESROS_R	05/01/1997	04/30/2003
Sperber Reservoir Discharge to Rubber C	SPE02	97SPERESRUB_R	05/01/1997	04/30/2003
Spruce Canal Interface	SPUI	08SPU___032_I	12/04/1997	04/30/2003
Spruce Canal Spill	SPSPA	08SP____036AS	01/24/1995	04/30/2003
Spruce Lateral 5 Spill	SP5SA	08SP5___087BS	01/18/1995	04/30/2003
Spruce Lateral 6 Interface	SP6I	08SP6___100_I	12/19/1997	04/30/2003
Spruce Lateral 6 Spill	SP6SA	08SP6___100AS	01/18/1995	04/30/2003
Standard Drain	STDDA	17STD_______D	05/04/1994	04/30/2003
Standard Lateral Heading SCW	STDHA	17STD_______H	07/07/1993	04/30/2003
Standard Lateral Interface	STDIA	17STD___018_I	01/31/1996	04/30/2003
Standard Lateral Spill	STDSA	17STD___019_S	07/07/1993	04/30/2003
Tamarack Lateral Interface	TMKI	08TAM___224_I	12/22/1997	04/30/2003
Timothy Lateral Interface	TIMI	08TIM___212_I	01/20/1998	04/30/2003
Township Drain to Alamo River	TOWSD	03TOW___030_D	06/08/1993	07/12/1995

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RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Township Drain to Holtville Drain 8	TWH8D	03TOW___023_D	06/07/1993	07/12/1995
Township Drain to Holtville Main Drain	TWHMD	03TOW___020_D	05/22/1993	07/12/1995
Township Lateral Interface	TOWIA	03TOW___030_I	06/11/1993	04/30/2003
Township Lateral Spill	TOWSA	03TOW___030_S	02/05/1993	04/30/2003
Trifolium Interceptor BCW at Willey Res	TRIW	08TRI___RES_W	12/22/1997	04/30/2003
Trifolium Interceptor Spill	TRSP	08TRI___RES_S	12/22/1997	04/30/2003
Trifolium Lateral 10 Interface	TR10I	08T10___200_I	12/22/1997	04/30/2003
Trifolium Lateral 11 Interface	TR11I	08T11___220_I	01/01/1998	04/30/2003
Trifolium Lateral 11 Spill	T11SA	08T11___220ES	02/08/1995	04/30/2003
Trifolium Lateral 12 Heading BCW	T12HA	15T12_______H	05/13/1994	04/30/2003
Trifolium Lateral 12 Interface	TR12I	08T12___232_I	01/20/1998	04/30/2003
Trifolium Lateral 12 Spill	T12S	15T12___237_S	03/01/1996	04/30/2003
Trifolium Lateral 12 Spill (94/95)	T12SA	15T12___238_S	03/04/1994	09/17/1995
Trifolium Lateral 13 Heading BCW	LT13A	15T13_______H	02/01/1994	04/30/2003
Trifolium Lateral 13 Spill	T13SA	15T13___259_S	03/04/1994	04/30/2003
Trifolium Lateral 2 Interface	TR02I	08T2____036_I	01/13/1998	04/30/2003
Trifolium Lateral 2 Spill	T02S	08T2____036_S	01/17/1996	04/30/2003
Trifolium Lateral 2 Spill (1995)	T02SA	08T2____038_S	01/18/1995	01/16/1996
Trifolium Lateral 3 Interface	TR03I	08T3____055_I	12/22/1997	04/30/2003
Trifolium Lateral 4 Interface	TR04I	08T4____079_I	12/22/1997	04/30/2003
Trifolium Lateral 4 Spill	T04SA	08T4____079_S	01/18/1995	04/30/2003
Trifolium Lateral 5 Interface	TR05I	08T5____098AI	12/22/1997	04/30/2003
Trifolium Lateral 6 Interface	TR06I	08T6____118_I	04/09/1998	04/30/2003
Trifolium Lateral 7 Interface	TR07I	08T7____137_I	12/22/1997	04/30/2003
Trifolium Lateral 7 Spill	T07SA	15T7____140AS	01/15/1994	04/30/2003
Trifolium Lateral 8 Heading BCW	T08HA	15T8________H	07/13/1994	04/30/2003
Trifolium Lateral 8 Interface	TR08I	08T8____155_I	12/22/1997	04/30/2003
Trifolium Lateral 8 Spill	T08SA	15T8____160_S	10/31/1994	04/30/2003
Trifolium Lateral 9 Heading BCW	T09HA	15T9________H	05/13/1994	04/30/2003
Trifolium Lateral 9 Interface	TR09I	08T9____180FI	01/01/1998	04/30/2003
Trifolium Lateral 9 Spill	T09SA	15T9____180ES	03/03/1994	04/24/1997

WIS Data Available

RTU's + PLC's Site Name	Rep Name	Site Code	From Date	To Date
Vail Canal Heading	VMHA	97VM_____VS_H	08/11/1997	04/30/2003
Vail Canal IG to Willey Reservoir	VMI	08VM____701_I	12/22/1997	04/30/2003
Vail Canal Spill	VMSPA	17VM____701_S	12/19/1993	04/30/2003
Vail Lateral 4 IG to Kate's Lake	VLAT4	97V4____409_I	09/28/2000	**04/15/2003**
Vail Lateral 6 Spill	154	19V6____612_S	10/21/1998	04/30/2003
Vail Supply Canal Drop 41	VS41	17VS____041_W	05/09/1996	04/30/2003
Vail Supply Canal Heading Drop 0	VS0H	97VS____000_H	10/03/1997	04/30/2003
Vail Supply Canal Heading Drop 2	VS2H	19VS____002_H	03/13/1996	04/30/2003
Vail Supply Canal IG to Russell Res	RUSI	17VS__RUSRESI	03/13/1997	04/30/2003
Vail Supply Canal IG to Young Reservoir	MDRI	17VS____040AI	05/07/1996	04/30/2003
Vail Supply Canal Spill at North End Dam	VNEDA	17VM____NED_S	07/02/1994	04/30/2003
Walnut Lateral Heading	WNUT	97WAL_______H	01/23/2003	**02/10/2003**
Westside Main Canal Heading at Weir 1	WSMH	97WSM___AAC_H	08/11/1997	04/30/2003
Westside Main Canal Sp to Trif Storm Dr	WSMSA	01WSM___100_S	07/06/1995	04/30/2003
Westside Main Dixie 6 Spill	DX06A	97WSM___DIX6S	08/06/1997	04/30/2003
Westside Main Dixie Spill	DXSP	97WSM___DIX_S	02/01/2001	04/30/2003
Westside Main IG to Carter Reservoir	CARI	97WSM___CAR_I	05/01/1997	04/30/2003
Willey Reservoir Discharge	TRES	08TRIRES____R	02/17/1998	04/30/2003
Wisteria Canal Heading	WIST	97WST_______H	01/23/2003	04/30/2003
Woodbine Heading	WBIN	97WB________H	11/05/2002	04/30/2003
Woodbine Lateral 2 Heading	WBL2	97WB2_______H	11/06/2002	04/30/2003
Woodbine Lateral 3 Heading	WBL3	97WB3_______H	11/06/2002	04/30/2003
Wormwood Canal Heading	WWOD	97WW________H	01/23/2003	04/30/2003
Wormwood Canal Spill	183	19WW____088_S	01/24/2001	04/30/2003
Wormwood Lateral Heading BCW	WWODH	97WW________H	01/22/2003	04/30/2003
Young Reservoir Discharge	MUDR	17MDRES_____R	05/09/1996	04/30/2003

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208 PLANNING STUDY
AGRICULTURAL WASTEWATER PRACTICES

1978

Coachella Valley County Water District
Agreement No. 7-047-17-8

PREFACE

This report was prepared in response to an agreement between the Coachella Valley County Water District and the California Regional Quality Control Board, Colorado River Region for Agricultural Drainage Planning, No. 7-047-17-8, dated February 17, 1978. The report was prepared by Arthur F. Pillsbury, Springville, California, retired irrigation engineer and hydrologist who was one of the initiators, and a field representative of the University of California, of drainage and irrigation studies in the Coachella Valley beginning in 1932. He was later a member of the Drainage Cooperators Committee made up of University of California, U. S. Salinity Laboratory, U. S. Bureau of Reclamation and the Coachella Valley County Water District. Arthur F. Pillsbury is Professor Emeritus of Engineering and Applied Science; Director, systemside Water Resources Center, 1966 - 1972; former Irrigation Engineer and Professor of Irrigation and Soil Science, University of California Los Angeles; member, California State Environmental Quality Study Council during its three year life, 1969 - 1972.

"The entire section of country herein described is known to be a desert waste, devoid of water and vegetation, owing to which it represents a great barrier to travel, and transportation, on the most approved route of land communication between the Atlantic and the Pacific."

Excerpt from Joint Resolution No. XXVIII Acts of the

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SUMMARY

Historically, the early decisions of the Coachella Valley County Water District to 1) line the last 38 miles of the Coachella Canal of the All-American Canal from near Mecca to the terminous, and to provide for an underground distribution system for the delivery of water in Improvement District No. 1, the canal water service area, has proven provident; 2) the piping of the underground drainage system minimizes seepage, erosion, tail water runoff from irrigated fields, as well as waste of usable, tillable agricultural land, has also proven to be the wisest choice, and 3) the use of farm tile systems which connect into the Districts underground collector system has minimized or eliminated pesticide and sediment problems.

These programs have provided for the best use of land and water. Because of the canal lining, the underground distribution system, and the underground tile drainage and drainage collector system, with relatively few open drains, the quality of Coachella Valley's environment is far superior to similar desert irrigated areas. These minimize the vast dredging and herbicides utilized in other districts. The projected lining of the first 49 miles of the Coachella Canal is the result of findings so fortuitously obtained in the 1940's.

The foresightedness of the people of the District in beginning studies of irrigation and ground water hydrology as early as 1932, and even before, have borne fruit. These decisions have made possible efficient and beneficial use of water and land, improved water management and crop production. This is borne out by the record yields of agriculture, which have been substantiated in comparison with other western irrigated areas.

The hazards and problems of salinity, recognized early in the District's history, has enabled the District to effectively meet requirements to reduce salinity in soils, and for farmers to improve agricultural practices and land use. Salinity control has long been a major thrust of the District's operations. Not only has the District kept close surveillance, but it has maintained staff and laboratory facilities to continuously monitor its salinity and drainage programs. The salt balance of the Valley has been roughly maintained, and land is arable rather than a salt encrusted wasteland.

The Salton Sea is the natural and legally preserved reservoir and repository of agricultural waste waters by the 1924 Presidential Order of Withdrawal. The level of the Sea for fish, wildlife recreational or other uses cannot be guaranteed. Its level is subject to the reception of all waters which, in addition to agricultural waste waters, are surface and storm waters. The September 1976 and 1977 rains, for example, added more than 100,000 acre feet to the Sea's volume. The sink, historically, has been the repository of the drainage waters of an immense watershed extending from the San Gorgonio, the San Jacinto, the Little San Bernardino Mountains and the eastern slope of the peninsular range, to well into Mexico. Also, part of the time in the past, the entire Colorado River emptied into it.

Without the nutrient elements of salts, there would be no life on earth. Nutrients in water are essential for an aquatic food web, without which there would be no fish. While the nutrients in the open drain waters are adequate for a good food web, there is no evidence of their being in any way excessive.

Problems of pesticide residues in the open ditch waters are minimized because the nature of the closed irrigation system, and because of the relatively short irrigation runs. This severely restricts any aerial application of pesticides; so there is much less drift of these than in other irrigated areas. It is against District policy for tail water (surface wasteage of irrigation water) to be dumped into open ditches. However, some land does abut open drains, and there may be some surreptitious dumping of tail water into the drains. Water discharged through the tile drainage systems has passed through unsaturated soil. Because of the vast water-soil air interfaces existing in unsaturated soil, there is better opportunity for decomposition of pesticide residues there than in any other environment. Thus, it would be surface tail water, rather than tile drainage effluent, that would be the source of any high pesticide residues in the ditch waters. High pesticide residues are unlikely, since there is little evidence of pesticide problems in this District or irrigation surface water runoff because of closed drains.

Surface, sprinkler, and drip/trickle irrigation are all employed in the District as irrigators seek the most efficient, and the most economical, method for their particular soil and crops. There are advantages, disadvantages, and economics involved with the several methods. Continuing studies indicate that most farmers are tending to utilize methods that do not create tail water. Open drains are utilized in the District only in areas adjacent to Salton Sea and are required for carrying off stormwaters such as the Coachella Valley Stormwater Channel. They may in a few instances also include the dual function of carrying off stormwaters as well as agricultural drainage waters.

The District's biological control of weeds in the relatively few open drains, near the Sea, has been most effective, and has greatly reduced the necessary application of herbicides and dredging. This helps preserve a good environment for fish and wildlife. Despite the actions of tresspassing fishermen, the District's success with Tilapia Zillii, a vegetation eating fish, has attracted the attention of water and other agencies throughout the west. Tilapia Zilli offers evidence that the White Amur, a hardier species, would provide more efficient and economical biological control of vegetation.

As to alternatives and Best Management Practices, the following are the major findings:

--Enhancing the Salton Sea fishery is not necessarily within the province or capabilities of the District. The future may resolve this with or without changes in present practices, which actually benefit the Sea's ecology. Any changes would have little effect on the course of history in regard to irrigation drainage water. The quantity of water available for irrigation, the salinity of that water, the Central Arizona Project, and the Upper Colorado River Basin States, all using their full entitlement, will have a direct effect.

--Agriculture's rather rare surface water runoff is largely due to very infrequent precipitation, and does not come from irrigation water. The Coachella Valley Stormwater Channel drains the central portion of the planning area receiving precipitation runoff from roadside drains, and receives the discharges from the District's drain tile collector system. This major man-made flood and stormwater channel, because of stormwater sediment deposits, requires dredging to maintain brush and vegetation controls and efficient disposal of flood waters, and maintenance at the mouth of the channel at the Sea, because of the buildup of its delta by sediments. The few other drain channels must also be kept open to serve both the discharge of agricultural drainage and of excessive precipitation. There is no good evidence that turbidity is a major problem in Coachella Valley.

--Proposed new irrigation methods are not a solution in themselves since present methods are adequate and efficient. If anything, less irrigating by some methods would require more leaching. Less irrigation could reduce discharges into the drains and the Sea, and would thus reduce open drain fisheries, and increase the salinity of the Salton Sea. Application efficiency in the District is generally adequate, and the alternatives of sprinkler or drip/trickle depends upon the crops planted and upon the soil; thus they are not complete anwers. Little environmental impact is expected as these methods may be more frequently applied as irrigators acquire expertise. The quality of the environment has been greatly enhanced by irrigation in this District. Without irrigation and agriculture, the Valley would have remained a desert devoid of fish life.

--Aquatic weed controls through expansion of the present biological controls such as the use of Tilapia Zillii, an East African weed-eating fish which has proven effective except for climatic conditions, could be enhanced through introduction of a more temperature-tolerant Siberian fish white amur (Ctenopharyngodon idella) which has been studied, researched, and accepted with a large body of knowledge already accumulated by the States of Arkansas, Florida and Texas. The Coachella Valley would provide an ideal research setting for controlled experiment in the use of these fish.

--Finally, the District is fortunate that it had early anticipation and preparation. Its foresightedness has been reinforced, and all research studies indicate alternatives to present practices could be more injurious to the environment. The present management practices are those that will continue to enhance and improve the quality of the entire area's environment.

AGRICULTURAL WASTEWATER DISCHARGE

208 PLANNING REPORT

I. INTRODUCTION

A. Purpose and Scope

By Agreement No. 7-047-17-8 entered into on October 1, 1977, between the Coachella Valley County Water District (hereinafter referred to as the District), and the California Water Resources Control Board (hereinafter referred to as the Board), the District has assumed responsibility for Agricultural Drainage Planning.

The Agreement, with a five page EXHIBIT A made a part thereof, is concerned with development of Alternative Management Practices, with identification of Best Management Practices (BMP) and the Management Agencies recommended for implementation, with Environmental Impact Assessment, and with coordination, reports, and data requirements, etc.

For well over 40 years, the Coachella Valley County Water District has been striving to improve the quality of the environment in the Valley, largely through the enlightened management of its water supply, the development of which it had contracted for. Now, newcomers are saying that there was no concern for the quality of the environment until they arrived on the scene. Further, they say that, to be objective, those with a history of concern, must prove beyond a shadow of doubt that their practices provide a pristine pure environment. On the contrary, we state that the newcomers must prove beyond a shadow of a doubt that the carefully selected and time proven practices well established are faulty before they will be abandoned or modified. In this regard, it is interesting to note a recent article (52) which shows quite conclusively that local inputs, rather than broad comprehensive national concepts, control the quality of the environment.

There have further been statements to the effect that the utilization of water in the desert "alters and destroys the area's natural desert environment." Technically, this is correct if the absurd assumption is made that man should not be a part of the natural desert environment. Actually, there is only sufficient water to affect a very tiny fraction of the Sonoran Desert, and there will always be plenty of "natural" desert. Man is a part of the environment, and, because overall he is so industrious and productive, a few of his race can decry that he has changed or destroyed something natural - regardless of how worthless that which is destroyed can be. Man exists because he does drastically alter the environment - and only man is concerned about the quality of the environment.

B. Description of Area

The area of concern is that portion of Coachella Valley to which Colorado River water is imported. It is a desert area whose precipitation averages less than 3 inches per year, a portion of that often coming from late summer thunder storms. Coachella Valley, as a whole, is the northwesterly portion of a closed basin that drains to the present Salton Sea, now about 228 feet below sea level, and which has been a natural sink for eons. The apex of the alluvial fan formed by the Colorado River is in Mexico, and all of the Imperial Valley of California, and a good part of the Mexicali Valley in Mexico, as well as the Coachella Valley, drain towards the Salton Sea. The other side of the alluvial fan of the Colorado River, all in Mexico, drains towards the Gulf of California. The soils of the Imperial Valley, southeast of the Salton Sea, are dominantly alluviums deposited by the Colorado River. The dominant soils of the Coachella Valley are wind-modified recent alluviums eroded from the granitic mountains which, except for the Salton Sea side, surround the Valley. Going counter-clockwise around the Valley from Salton Sea, these are the Little San Bernardino Mountains, the San Bernardino Mountains, the San Jacinto Mountains, and the Santa Rosa Mountains. (See Maps 1A and 48-A).

Coachella Valley is divided into two parts. The upper basin is that area lying to the north and west of a line drawn from Point Happy near Washington Street north and east toward the Indio Hills.

The lower basin, subject of this 208 Planning Report, lies to the south and east of the line beginning at Point Happy. In the lower basin are the cities and communities of Indio, Coachella, La Quinta, Thermal, Mecca, North Shore and Oasis, including the irrigated agricultural areas served by the Colorado River through the Coachella Branch of the All-American Canal which, by contract with the United States, is known as Improvement District No. 1. (Map 48-A).

Generally there is an almost complete lack of well defined stream channels throughout the Valley, except in a few locations where slopes are greater than normal. The few perennial streams disappear, with normal flow, in the alluvial fans before they reach the Valley. When floods do occur, the water with its heavy sediment load tends to fan out irregularly, with extremely shallow depth of flow. This is part of the natural aggregation process by which alluvium is built up over a plain. To make the Valley reasonably safe from the devastating effects of the infrequent floods, levees have been built, utilizing material from the artificial channels thus created. Sometimes, where the slope is steep enough, natural channels do exist, and are smoothed and regularized with levees constructed to make them more permanent. Both the artificial stormwater channels thus created, and the open drains dug to provide outlets for the tile drainage system, generally, must be continually maintained. Without such maintenance, they would revert to the broad and ever changing shallow natural fans. The Valley would cease to be an environment suitable for man, for a productive agriculture, and there would certainly be no fish. The natural desert ecosystem would be in full swing.

1. Climate

The mean annual temperature of the Valley 73°F, with an average annual minimum of 54°. The highest temperature is 125°F, the lowest is 16°F. Daytime summer temperatures can be expected to exceed 100°F, and nighttime summer temperatures are expected to exceed 90°F. There are light frosts from time to time in some winters, but temperatures are normally above freezing. Prevailing light winds are from the south and southeast. There are seasonal strong winds from the northwest, out of the San Gorgonio Pass area, usually during March, April and October, due largely to coastal pressure systems. Velocities are up to 60 miles an hour, and, in places, severe gusting, blowing sand and dust conditions prevail.

District records and those of the National Weather Service at Thermal indicate that humidity in the lower basin of the Valley (below Point Happy) has ranged from an average of 28% in June to a high average of 48% in December over the past 30 years. During the past 10 years the lowest temperature in the Valley was 17°F on January 5, 1972, and the highest 118°F on July 11, 1975. Every month of the year has had temperatures of 90°F.

According to rainfall measurements in Indio since 1877 the least amount of precipitation was recorded in 1894 when only a trace was listed. In 1886, during the entire year, .12 of an inch fell, and that was in November. The most amount of rain was in September 1939 when 8.96 was recorded and the year's total was 10.85 inches. The next highest rainfall of record was in 1976 with 5.24 recorded in September in Indio. Average rainfall since 1877 has been about 2.60 inches.

Owing to high temperatures, almost daily sunshine, and low humidity, evaporation is high every month of the year with maximums during the summer months.

2. History

Prior to the Pacific Railroad Survey made by the U. S. Army Engineers in 1853, information about the Coachella Valley and the Colorado Desert is sketchy. Few written reports exist, those being of Spanish expeditions, the diaries of the Spanish padres, or others. Concerning the Coachella Valley, the few reports told mostly of Indian Trails through the San Gorgonio Pass to the Colorado River. Some told of salt being obtained from the Salton Sink.(1)

The earliest recorded report of Coachella Valley was made during an expedition of Captain Jose Romero and Lt. Estudillo in December 1823. They sought a route to the Colorado, the Yuma Settlement and thence to Tucson. They failed to reach the river and were forced to return to San Gabriel. They reported no trails, scarce water holes, and impossible conditions on the bleak and formidable desert. In 1825 a second expedition succeeded in reaching the river at considerable cost.(1)

California was admitted to the Union September 9, 1850. The need for communication and travel, among other things, led two engineering parties into the Coachella Valley in 1853. One was that of Col. Henry Washington who not only named Cathedral Canyon but his surveying parties established the San Bernardino Base and Meridian upon which modern day land surveys are based and land ownerships detailed.(1)

Probably one of the most important expeditions was that under the direction of Lt. R. S. Williamson, who sent a party including Prof. William P. Blake, of the Smithsonian Institute, and a party chief, Lt. J. G. Parke, through the San Gorgonio Pass in November 1853. The comprehensive and voluminous report described the winds, the barrenness, the botany and the topography of the Valley, as well as its water holes, Indian wells and springs. It was Prof. Blake who first noted the ancient fresh water beach line on the foothills of the Santa Rosas. He named the body of water that had filled the Salton Sink some 400 years earlier to the nearly 35-foot above sea level mark "Lake Cahuilla" after the Indians living on the desert. He also gave the name "Colorado Desert" to this region.

In a letter written April 14, 1860, a John Rains wrote Dr. Oliver Wozencraft, who had a vision of irrigating the desert, that he had crossed and recrossed the desert many times and that "there is no portion of it, with the exception of the Indian rancherie (sic), at the opening of the San Gargonio (sic) Pass, on which man or animal could subsist, or any portion of it that could be sold for any consideration, as there is neither water nor vegetation, and the excessive heat and drifting sands make it extremely difficult to pass over it, owing to which there has been great suffering, loss of life and property....." (Arizona vs. California Exhibits Volume I).

Discovery of gold at La Paz on the Colorado River in 1862 brought many prospectors and travellers through the Coachella Valley. This traffic led William D. Bradshaw, who had a part in the Bear Flag revolt, to build a freighting road through the Valley which was used nearly 20 years by stage lines to Prescott, Arizona.

In 1875 and 1876 Lt. George M. Wheeler, in his report to the Chief of Engineers, War Department, Second Session, 44th Congress, as to "the feasibility of diverting waters of the Colorado River of the West for purposes of irrigation...." made a number of interesting comments. Summer and winter trips were made by Lt. Eric Bergland in the field. Lt. Wheeler in his 1875 trip declared that "the unfortunate climate to which this portion of the Southwest (Colorado Desert) is at present treated by the hand of nature is likely to retard its rapid settlement, even if water was plentifully available...."

Bergland wrote that on the 1875 trip "from Ehrenberg we followed old stage road to Chuckawalla, thence to Dos Palmas, Los Torros, Agua Caliente, Whitewater, through the San Gorgonio Pass.....from Los Torros to Agua Caliente it is very sandy and difficult for wagons. This portion of the Coahuila (sic) Valley is covered with immense sand hills, some of which seem to be permanent, as large-sized mesquite and other brush grow on their summits. Others are constantly shifting their position, according to the direction of the prevailing winds...."

On Lt. Bergland's second survey in February 1876 through the Pass to the river he wrote the following impressions: "The country appeared more sterile and forbidding than before, as the mesquite trees had lost their leaves, and not a spear of green grass was seen between Whitewater and Ehrenberg...." Regarding the climate, he added this observation: "The climate in the Colorado Valley during the hot months is not one which a sane person would select in which to spend the summer...."

All of the early writers and observers wrote of their experiences with the prevailing winds from the south and southeast, and especially commented on the violent winds and windstorms with blowing sand from the northwest and west.

Drifts of sand and dunes were noted as far south as Thermal, in the center of the Valley, and on both edges of the Valley. Little rain was noted except for thunderstorms in the late summer, fall or early winter, sending flooding and rampaging water out of the mountains onto the floor of the desert valley. Generally low humidity was noted except during the summer when prevailing winds brought in moist air from the Gulf of California, as they do today.

The desert entry act permitting homesteading in 1885 along with prospecting and mining, the completion of the Southern Pacific Railroad to El Paso, discovery of artesian water, and the beginning of agriculture all brought settlers to the area from Mecca to Indio prior to the turn of the century. The establishment of the date industry, planting of vineyards and citrus along with early vegetables with irrigation from wells influenced settlement.

The need was early evidenced for a supplemental supply of water if the economy of the area was to grow. This led to the establishment of the Coachella Valley County Water District and joining efforts with Imperial Valley in obtaining Colorado River water. The political actions and pioneering efforts led to the Boulder Canyon Project Act and provisions for the All American Canal with a Coachella Branch. First river water was delivered in the valley in 1948. The following report includes other details of this agricultural growth.

3. Economics

Population of the Planning Area is estimated to be approximately 43,000 of which about 19,100 reside in the corporate limits of the City of Indio, and about 8,400 in Coachella. In the unincorporated areas are the communities of La Quinta, Thermal, Mecca, North Shore and Oasis with a population of approximatley 15,500. (Estimates January 1978 Coachella Valley Association of Governments.)

The planning area is largely agriculturally oriented. Of the about 78,000 acres of irrigable land, which has Colorado River water available, more than 58,000 acres were farmed producing vegetables, grapes, tree crops, cereals, forage and nursery crops. Nearly 11,000 acres were fallow or idle during 1977.

Agriculture reported a gross crop value of nearly $107,000,000 or more than $1870 per acre, making this area one of the highest producing irrigated districts in the 11 western reclamation states. The District also has the distinction of using a greater percentage of its water beneficially according to the U.S. Bureau of Reclamation. In 1977 there were 806 irrigation water users in the District.

Agriculture's importance to the economy is also evidenced by the number and residence of year-round farm workers as well as employment in agriculturally-oriented industries such as packing, transportation, shipping and related industries.

The balance of the planning area's economy includes tourism, recreation, commerce, construction, industry and government.

Among the golf courses in the area are La Quinta, Westward Ho, Bermuda Dunes, Indian Palms and the Indio Municipal Golf Course. The first four have attendant fairway residential developments.

Using the City of Indio's economy, with its mix of recreational and agricultural activities, trends and outlooks for the area can be analyzed and projected since Indio is the primary urban center for the planning area (49).

Until recent years the planning area has been dominated by agricultural influences while the upper basin has been primarily a tourist, recreational and resort center. The distinction is now somewhat less pronounced.

Because of the agricultural influence, the planning area's economy has rarely had the fluctuations noted in the upper basin.

Indio's population, for example, ranged from 9,745 in 1960, and 14,459 in 1970 to more than 19,100 in 1977. The planning area's population was 27,265 in 1960, was 38,400 in 1970 and is now about 43,000. In 1950 there were 1955 dwelling units in Indio and by 1976 the number had reached nearly 7300. In 1948 the city limits of Indio totalled about five-eighths of a square mile, by 1960 it had increased to 5.5 square miles and in 1977 was more than 12 square miles (50). Employment in agriculture was estimated at 4.8 per cent of the population in 1960 and six per cent in 1970, an increase of 25 per cent, which is understandable since Indio historically has been the economic center for agriculture. Crop bearing acreages from 1950 to 1976, from 26,500 to about 63,000 acres, has nearly tripled, according to the Riverside County Agricultural Commissioner's Annual Report.

In 1976 tourism, including seasonal population for the winter months in Indio, totalled nearly 1,500 or about 7.6 percent of the population which added a source of income and generation of employment. The future growth of this segment of the economy is promising as tourism increases in the entire planning area. Tourism growth due to the Salton Sea, the state park and recreational facilities, terminal reservoir Lake Cahuilla and mobile home parks, also have an impact on the area.

Per capita retail sales according to the State Board of Equalization Taxable Retail Sales in California, 1976, shows Indio with \$102.1 millions and a per capita retail sales of \$5,361, exceeding the averages of other valley cities, the county and state. Palm Springs showed \$5,123 and the county \$2,522 in per capita sales. This illustrates Indio's role as the center of sales and service not only for the lower valley but the upper valley, Salton Sea and Eagle Mountain areas as well. It should be noted Indio's sales included 10 percent for building materials and farm implements and 23 percent for auto and truck dealers.

Income from agriculture is expected to grow in the future at the rate of about three to 3½ percent (49). A growing share of the entire valley's seasonal, retired, and tourism population is expected to be attracted to Indio and the planning area, especially as it relates to mobile home parks. Coachella Valley Association of Governments forecasts a population growth of 30,000 more by 1990, for example.

In 1977 construction in the planning area totalled more than \$14,000,000 and retail sales in the area totalled nearly \$160,000,000.

The growth of the area can also be illustrated by the increases in assessed valuation in Improvement District No. 1, the area receiving Colorado River water for irrigation. According to the Riverside County assessment rolls the assessed valuation in the 1949-50 year was \$9.5 millions. In 1959-60 year it reached \$20.8 millions and in the 1977-78 year it was \$46.3 millions. The valuations, it will be noted, doubled each ten-year period.

Besides the Southern Pacific's main line between Los Angeles and El Paso, which also handles ore trains from Eagle Mountain's Kaiser Mine daily, the area is served by major airlines operating out of the Palm Springs Airport with some charter service out of Bermuda Dunes and Thermal Airports.

Greyhound and Trailways bus lines operate out of Indio and Coachella as well as major freight and trucking lines. Interstate 10 traverses the north side of the area. Highway 111 bisects the valley from Indio around the north shore of Salton Sea while Highway 86 originates at Indio and continues around the west and south shore of the sea. Other state routes are located from Valerie Jean through Box Canyon and from Oasis to Pierce Street.

C. Agriculture

1. Water Supply

Irrigated agriculture really got its start about the turn of the century, except for small trial plantings and a few home gardens which started a few years earlier. The sole source of water was the ground water that was generally artesian with flowing wells up the Valley from Salton Sea to about present day Indio. The ground water is derived from the natural recharge of the Whitewater River and its tributaries. Early wells were often drilled using a jetting technique but flow of such wells was generally small. Good flows were generally obtained first with the conventional cable tool (percussion) technique, and later with the hydraulic-rotary technique. Over a relatively few years, as irrigated agriculture expanded, the water table receded, and the wells ceased to flow, except for a few near the Salton Sea. Essentially all wells, then had to be pumped, although they were still artesian in principle.

Because of the problem of the continuing lowering of the water table, it became obvious that the water supply had to be supplemented. When knowledge was gained that the people of the Imperial Valley were talking about an All-American Canal, at a considerably higher elevation than the Alamo Canal that had been bringing water north from Mexico, it became apparent that Coachella Valley could also be served with Colorado River water by gravity. (1) Therefore, in 1918, the then sparse population of the Valley voted overwhelmingly to form the Coachella Valley County Water District. Some people of the Valley involved themselves rather thoroughly in negotiations with the Imperial Irrigation District, with representatives of the western states within the Colorado River drainage area, with the Federal Reclamation Service and with the Congress. This involved a long period of negotiations; so more immediate attention was given to stream runoff water conservation and to improvement of the natural recharge capabilities of the Whitewater River and its tributaries. Adjudication of the surface waters was commenced in 1919 and became a major emphasis, as well. Levees were constructed to divert and detain flood flows of the Whitewater and San Gorgonio so as to increase recharge. Later, a study of the hydrology was undertaken largely in the period 1936 to 1945. It was published in 1948. (2) This information indicated that the maximum safe yield of the underground system was somewhere in the neighborhood of 100,000 acre feet per year, obviously only a small fraction of the actual needs. Later more detailed and comprehensive studies indicated that that rough estimate was a little high. (3), (4)

At the time that the Coachella Branch of the All-American Canal was being planned, the U.S. Bureau of Reclamation (hereinafter referred to as the Bureau) had had long experience with earth canals, some with clay lining, but no experience with concrete lined canals. Therefore, the first design of the Coachella Branch Canal was for an earth canal without lining. The District protested, and as a compromise, the Bureau agreed to line that portion of the canal within the District's boundaries.

Today the Bureau and the District have let one of two contracts to build a new lined canal, along and somewhat parallel to the old unlined canal for the first 49 miles from the Coachella turnout on the Main All-American Canal, thus saving some 132,000 acre feet per year of the present seepage, even though it would be lost to immediate use in the United States.

Again, with the distribution system, the original Bureau proposal was for a typical open ditch system. Because of the prevailing coarse textured soils of Coachella Valley, particularly around the periphery, there was strong District opposition to this proposal. Instead, a concrete pipe distribution system was requested. Because of the highly gypsiferous nature of Colorado River water, in contrast to the predominantly calcium-deficient ground waters of the Valley that caused them to make soils less pervious, open ditches were properly visualized as leading to excessive water-logging throughout much of the Valley. Also, there would be a great loss of water. The District was able to convince the Bureau to design, and to construct, their first-ever concrete pipe distribution system, a system that has performed remarkably well.

Legally, the area served with Colorado River water is the lower part of the Valley in "Improvement District No. 1". The Coachella Branch Canal provides the lower Valley below Point Happy with almost all of its irrigation water. (Map 48-A), Coachella Valley County Water District Ordinance 958 (Exhibit E-9) governs the delivery and use of Colorado River water for irrigation in Improvement District No. 1. It should be noted that all domestic water, at the present time, is obtained from wells.

Under the U. S. Supreme Court Decree of March 9, 1964, and the Secretary of Interior's Colorado River Operating Criteria (1970) California must reduce the water it takes from the Colorado River to 4.4 million acre feet per year when the Central Arizona Project (CAP) begins to divert substantial amounts of water. (The CAP is expected to be completed about 1986.) Considering the Mexico Treaty obligations, as well, the Colorado River is overcommitted -- more water allocated than it carries. However, the 132,000 acre feet of water "saved" by the lining of the first 49 miles of the Coachella Branch Canal should alleviate most of the District's water supply problems.

2. Soils

A soil survey was made of Coachella Valley in 1923, embracing 220,160 acres that appeared to have some agricultural potential. Of the area surveyed, about one-fourth is in the Coachella series, about one-fourth Indio series, and about one-fourth Superstition series. The remainder is in rough broken land, in Woodrow series, and in dune sand. Considerable dune sand has subsequently been levelled to more-or-less resemble the Coachella series. In general, the Superstition series is the coarsest textured soil, Coachella next, then Indio, and Woodrow is the finest textured. All are recent alluviums, but the Woodrow series is the one that, by far, appears to have the most of the Colorado River sediments settled out in ancient Lake Cahuilla. All of the soils are severely stratified with the texture of the strata ranging from coarse sand to clay. The strata are almost invariably quite discontinuous, often within distances of only a few feet. There are a few parcels of land that have been deep plowed to depths of 4 to 6 feet, before being levelled and irrigated. In general, this appears to have resulted in improved water management and crop uniformity.

3. Salinity

From the earliest records, there have been salt encrusted lands in the lower trough (center) of the Valley, and probably most of the people recognized the hazard of salinity problems. In 1927, a network of small rather shallow observation wells was installed in the saline part of the Valley(1) (2) to depths of 11 to 32 feet. Readings of the water levels in these "alkali wells" were made for some years by the District. The levels in these wells did not fluctuate as did the levels in the deep irrigation wells, but did gradually recede, with considerable lag, as the levels in the irrigation wells receded. Many of the observation wells were destroyed, or became inoperative for one reason or another, and were not replaced. Before too long, all were abandoned. They had told their story, however. The surface water table was semi-perched, but interconnected with the deep aquifers through tortuous channels. This made it rather obvious that, with the importation of Colorado River water, serious salinity and drainage problems would arise.

4. Drainage

Before the importation of Colorado River water, with dependence upon mining of the ground water, and with often isolated agricultural plantings being widely scattered through the Valley, there was simply no need for facilities to provide agricultural drainage. However, because of knowledge of underground stratigraphy, it was correctly forecast that there would be need for drainage facilities once Colorado River water was imported. This gave rise to cooperative investigations by the District, the University of California, the U. S. Salinity Laboratory, and the U. S. Bureau of Reclamation. The result was that there was a network of piezometers throughout the trough of the Valley, which piezometers were read periodically. Landowners were notified when the water table under any part of their land reached 10 feet below the surface, and the District had a pipe collector system available to provide outlets for farm tile systems. Nowhere else in the world have water logging and salinity problems been avoided before disaster struck. Details of the drainage investigations will be discussed later.

5. Crops

Table 1 shows summaries of acreage cropped in 1936-37, and in 1970 and in 1977. The gross crop value is shown for 1970 and 1977. (See Table 1.)

Historically, and disregarding some seedlings imported in 1890, dates have been grown in the Valley since the turn of the century. They were the first important crop, and have established the fame of Coachella Valley throughout the nation. Dates do better here than anywhere else in the United States, particularly the popular Deglet Noor variety.

TABLE 1

CROP SURVEYS OF COACHELLA VALLEY, CALIFORNIA

For 1936-37 - All of Valley up to Palm Desert and Thousand Palms
For 1970 and 1977 - Colorado River water service area only.

CROP	1936-37	1970		1977	
	Acreage	Acreage	Gross Value	Acreage	Gross Value
Cereals	670	1,917	$ 135,150	1,013	$ 110,650
Forage crops	1,440 !	5,894	721,254	5,929	2,038,854
Field crops (cotton)	1,460	3,238	671,440	5,400	2,739,888
Vegetable crops	3,660				
Carrots		5,040	7,285,824	5,294	9,813,488
Sweet corn		4,002	2,497,648	6,073	6,105,065
All others & melons		6,020	6,505,721	4,902	12,967,402
Seeds and Nursery		587	1,551,692	425	915,100
Citrus	2,735 *	16,955	10,543,710	16,016	22,130,517
Dates	2,865 *	3,442	6,780,500	4,093	10,783,710
Grapes	2,280	7,679	13,152,591	7,208	36,089,044
Other fruits and nuts	100	8	15,136	199	259,475
TOTAL - All crops	15,210	54,782	$50,342,098	56,552	$106,953,193
Less multiple cropped		7,039		7,248	
Net cropped land **	15,210	47,743		49,304	

* There were some 550 acres of dates and grapefruit interplanted in 1936-37. Half is credited to each of the crops.

! All was alfalfa.

** There were 470 acres of "part pasture" in 1936-37 - uncultivated land wild flooded from flowing wells. Not included in the total.

II. BACKGROUND ON THE AGRICULTURAL USE OF WATER

A. Uses of Water

California is the number one state of the nation in its agricultural productivity, and some 95% of that value comes from irrigated agriculture. Almost all agriculture in California depends upon irrigation. Rainfall, normally, is neither expected nor desired during that growing season, unlike the humid portions of the nation. Technically, the need for a supplemental water supply, and the cost of irrigation application, are over and above the costs of humid region agriculture. However, these extra costs pay off in yields, and in the quality and timing of the products. Georgia may be the "peach state", but some 90% of the nation's peaches comes from California. Thus, irrigated agriculture is complementary to humid region agriculture, and is a far more intensive agriculture. It not only makes the nation's food and fiber output the envy of the world; it, almost alone, keeps the nation's balance of payments from going through the ceiling. Along with cheap energy, it is agriculture that has made our transfer point, the Los Angeles Metropolitan area, prosper.

Urban people, most of whom have nothing to do with agriculture, except as ultimate consumers, heavily utilize Coachella Valley for play and escape. If the prosperity that enables them to do this is to long continue, they must learn that basic productivity comes first. Two examples follow:

(a) As part of its function in total water management, the District has dug and maintains open drains, mainly the Coachella Valley Stormwater Channel. These drains make possible the essential productivity of the agriculture, and provide for the channeling of flood flows to the Salton Sea. This has created an artificial environment that is optimal for certain fish species that the District has imported to keep the vegetation of the channels well pruned so as to lower maintenance costs, including dredging and herbicide spraying. Without agriculture, and without the costs of importing and maintaining the environment, there would be no sport fishery at all. Those who have created this fish environment, and maintain the environment for the fish must come first. The fish are not a free good for which the itinerant poachers have preference.

There are those who contend that the waters in the open drains are State owned, and that therefore all the resources in the drains are State owned. Two Attorney General opinions are cited to support this (#S65/173 and 65/259). Attention is directed to the fact that Attorney General opinions are not law, and that the drains, owned by the District, exist only because the District dug them and maintains them. Without that, there would be no drains and no fish.

(b) There is no environment more to his liking that urban man desires for his play and escape than the prime agricultural land. This land just happens to be the flood plain. But its very nature, because floods have deposited the alluvial soil to hundreds of feet in depth in geologically recent times, it is still subject to floods, and to all of the sediment that goes with them. Flood control techniques are employed, and do appreciably lengthen the probable period between devastating floods, but it can never eliminate them entirely. Thus, the flood plains work well for man's usual short-term of occupancy, but, because of the heavy sediment loads involved for the long-term, urban developments will ultimately suffer severely from the rare major flood. There can, of course, be losses to agriculture by a rare major flood. But, despite losses, agriculture has always rebounded and survived on the flood plain. Also, because of the sparse populations involved, those in agriculture can escape floods. Concentrations of urban man cannot.

The District does, of course, serve all of the water-related needs of the people. These include irrigation water supply, agricultural drainage, potable domestic water, urban waste water management, ground water recharge, water importation, and flood control. The District is essentially Valley-wide, and there are many economies in integrating the many phases of water management. But it is not the function of the District to dictate what people should do, and it follows the decisions made by the people and other governmental agencies in the most efficient and effective way possible.

B. On the Nature of Salts in Water

All natural waters contain salts, usually dominantly the chlorides, sulfates, carbonates, and bicarbonates of calcium, magnesium, and sodium. These salts are derived from decomposition of rock by the weathering process. The products of weathering are those salts, and the soil material that is periodically transported downstream in floods. The greatest amount of salts per unit of area are derived from the wettest watersheds. This is almost never recognized because there is so much more water produced that the salts are far more dilute (7, 8, 9). Since weathering requires a source of oxygen, it is basically a surface or near-surface phenomenon. Also, temperature changes affect weathering, particularly where moisture has penetrated into rock, and there is freezing and thawing. This is a surface phenomenon because temperature changes are so restricted to the surface. Temperature change is greatest on the highest watersheds. There is also opportunity for weathering around the shorelines of oceans, but this weathering is of far less concern than the weathering affecting all of our fresh waters.

1. Salinity of the Colorado River

The average annual salinity of the Colorado River ranges from about 50 milligrams per liter (mg/l) in its headwaters in Colorado and Wyoming, to 820 mg/l (1977) at Imperial Dam, the last diversion point in the United States. This increase is the result of two basic processes -- salt loading (adding salts) and salt concentration (reducing water supply). Salt loading results from both natural conditions and man's activities. Salt concentration results when water is lost through evaporation or transpiration within the Basin or when water of lower salinity than that of downstream points is diverted from the Basin. The result is an increase in downstream salinity due to the remaining amount of salt being carried in less water. It has been estimated that, under 1960 conditions, about one-half of the salinity concentration at Hoover Dam was due to natural conditions and one-half to man's activities (51).

A number of investigators have made projections of future salinity levels in the Colorado River. While the estimates differ, due to varying assumptions regarding long-term water supply and future rate of development, all agree that future salinities will increase markedly without the application of salinity control measures. The Colorado River Board of California has estimated that, without salinity control measures, the salinity at Imperial Dam will increase from its present (1977) 820 mg/l to approximately 1200 mg/l about the turn of the century. The increase will result mainly from increased water use for agricultural, industrial, and municipal purposes and out-of-basin exports as the states of the Upper Basin continue to develop their compact apportioned waters.

Following the enactment of P.L. 92-500, the Federal Water Pollution Control Act Amendments of 1972, the Environmental Protection Agency interpreted this legislation as requiring that numeric criteria for salinity be set on the Colorado River. Consequently, the seven Colorado River Basin states formed the "Colorado River Basin Salinity Control Forum" in 1973. The Forum was established to facilitate the development of uniform salinity standards for the Colorado River which would allow all Basin states to put their compact-apportioned waters to beneficial use while keeping the river's salinity in the Lower Basin near 1972 levels. (48, 51)

Since legislation was required to control the increasing salinity of the Colorado River and to enable the United States to comply with its 1973 agreement with Mexico on Colorado River Salinity, P.L. 93-320, the Colorado River Basin Salinity Control Act, was enacted in 1974. This legislation authorizes the Secretary of the Interior to proceed with a program of works for the enhancement and protection of water quality in the Colorado River for use in the United States and Mexico. The Act authorizes the construction, operation, and maintenance of a desalting complex and appurtenant works below Imperial Dam to enable the United States to comply with its obligations to Mexico as specified in the 1973 agreement between the two countries. In addition, the Act authorizes the construction of four salinity control units and identifies 12 other units for expedious completion of planning reports. The salinity control units, located above Imperial Dam and mostly in the Upper Basin, include:

(1) Irrigation source control projects which involve on-farm irrigation water scheduling, the management and improvement of water delivery systems, and the collection and use of irrigation return flows for industrial purposes.

(2) Point source control projects that include the collection of water from saline water sources such as wells or springs, and then either desalting the water or evaporating it in solar ponds.

(3) Diffuse source control projects that include the reduction of non-localized salt sources from relatively large areas by special collection processes followed by disposal processes similar to those for point sources.

The Colorado River Basin Salinity Control Forum, after conducting a number of studies that projected several levels of future streamflow, water use, and salinity levels, developed water quality standards for the Colorado River including numeric criteria and a plan of implementation for salinity control. The Forum concluded that numeric salinity criteria for the Colorado River should be established for three key locations, as follows:

Location	Salinity Criteria in mg/l
Below Hoover Dam	723
Below Parker Dam	747
Imperial Dam	879

These criteria represent the flow-weighted average annual values for the year 1972. It was recognized that many man-made and natural factors affected the river's salinity and that the actual salinity would vary above and below the criteria.

The principal elements of the plan developed by the Forum to meet the established numeric criteria are:

1. Prompt construction and operation of the initial four salinity control units authorized by Section 202, Title II of P.L. 93-320.

2. Construction of the 12 units listed in Section 203(a)(1), Title II of P.L. 93-320, or their equivalent after receipt of favorable planning reports.

3. The objective of no return of dissolved salts to the river from water diverted for industrial uses.

4. The reformulation of previously authorized, but unconstructed, federal water projects to reduce the salt loading effect of return flows.

5. Use of saline water for industrial purposes whenever practicable.

The plan also contemplates programs by water users to cope with the river's high salinity, improvements in irrigation systems and management to reduce salt pickup, studies of means to minimize salinity in municipal discharges, and studies of future possible salinity control programs.

All seven basin states have formally adopted the Forum's proposed standard as the standard for each state and the state-adopted standards have been approved by the environmental Protection Agency. In accordance with P.L. 92-500, the standards and plan of implementation are to be reviewed at three-year intervals. In this manner, the plan of implementation may be modified as required to assure achievement of the goal of maintaining the river's salinity at or below 1972 levels. (51)

The above actions and discussion concerning the Colorado River can only assume that (a) the amount of weathering, particularly on the high watersheds, can somehow be reduced, (b) that salts somehow can be safely stored somewhere on the watershed in perpetuity, or (c) the salts can be exported out of the watershed. So far as can be seen, the only real control will be the exports of salts to the Gulf of California in a brine line from the desalting works. Also, apparently, the desalting will be by one of the partial desalting techniques (reverse osmosis, electrodialysis, ion exchange). These are dominantly effective in removing the divalent ions, and not the monovalent ions. A resultant soft water may be good for some industrial uses, but not for agriculture. Calcium carbonate, magnesium carbonate, and calcium sulfate really do not contribute to salinity problems, and these are the primary salts to be eliminated by these techniques.**

C. The Salton Sea

When a river system disgorges into a sink, or into an alluvial valley, the sediments that it carries form a delta or alluvial fan. At one time or another, the water will flow to one side or the

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***The above discussion on the "Salinity of the Colorado River", as developed largely by personnel of the Colorado River Board of California, represents the official position of the District, of the Colorado Basin States, and of the federal and state regulatory agencies. The writer has a different viewpoint. Salts as found in all natural waters are dominantly and basically the result of the weathering process. The minerals in rock at or near the surface of the earth are decomposed in the presence of air. It is a surface phencomenon because that is where there are great temperature changes (such as freezing and thawing), where there is plenty of oxygen (no saturated ground water), and where there is the most wetting and drying. Weathering is greatest in the high mountains because that is where rock is at, or close to, the surface, and where there is the most wetting and drying.*

There is no evidence that man, in any really significant way, has really ever changed the production of salts in weathering. One physical mechanism other of the alluvial fan or delta. Because of floods, and the heavy sediment load involved with floods, it is axiomatic that about as much sediment will be deposited on one side of the fan or delta as on the other side. This certainly holds true for the Colorado River where there is at least as much alluvium on the Salton Sea side as on the Gulf side. The apex of the fan must have always been not too far from Morelos Dam. When white man first passed through this area it was reported that small saline Lake existed in the Salton Sink (1). There were later reports of a dry Salton Sink. There was a well established salt works at the bottom of the sink (1). And, today, there is still the evidence of a long time maximum elevation of ancient Lake Cahuilla at Travertine Point, and up and down the valley from that point. This elevation is variously reported as being about 35 feet above sea level. This would permit the water to flow over the low point of the fan to the Gulf (1). It is unknown how often there were periods when Lake Cahuilla existed, but there must have been many. There are the remains of rock work near the shores of Lake Cahuilla, usually presumed to be some kind of fish traps (1). There is also the old salt works, and the surprising depths of crystalline salt penetrated by well drilling near the shores of the southeast side of Salton Sea.

Before 1905 the Salton Sink had a saline marsh in the bottom extremities. Heavy flows of the Colorado River and Gila River flowed uncontrolled into the Salton Sink in 1905, using old river channels cutting new channels (1). The railroad through the Sink was forced to relocate its tracks to keep them from being innundated or washed away. There was fear the tracks would have to be moved again. Therefore, it is not surprising that the Southern Pacific Railroad became the agency responsible for turning the River back to the Gulf. The railroad succeeded in 1907, and measures were taken which, it was hoped, would keep the River flowing towards the Gulf "at all future times". When the River was turned back, Salton Sea had reached an elevation of -195 feet, reaching the present community of Mecca. The level immediately began receding.

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in weathering is the grinding of rock materials, particularly with the carrying of rock debris as bed load in floods. The construction of dams all up and down the Colorado River has been quite effective in reducing the energy basic to flood flows, and thus in a small way, has decreased nature's production of salts. That is really the only mechanism observed that man has affected the production of salts.

The second aspect of the salinity problem is concentration of salts because of evaporation and evapotranspiration, wherein pure water is lost from the liquid to the vapor phase, and all salts are concentrated into the remaining water. Water development greatly increases the water surfaces subject to evaporation. Also, on the Colorado River, with the more uniform and sustained flow of development, there has been a tremendous invasion of phreatophytes that never existed in nature. This further increases evapotranspiration. By far the greatest mechanism of concentration, however, is irrigated agriculture. Something between 40 to 90 per cent of the applied water is lost to evapotranspiration, with vast areas involved. Although realtively minor now, there are urban and industrial uses of water on the Colorado River system. Basically, these add salts to the system in

On March 10, 1924, President Calvin Coolidge signed an Order of Withdrawal (Public Water Reserve No. 90, California), involving approximately 104,240 acres".....in order that the lands affected thereby may be reserved for the purpose of creating a reservoir in Salton Sea for storage of waste and seepage water from irrigated land in Imperial Valley, California". Unfortunately, alternative sections of land had previously been granted to the Southern Pacific Railroad, since it was dry land when the railroad was built. There had also been some withdrawals as mining claims, homesteads, etc. Thereafter, Imperial Irrigation District bought such lands as could be purchased for a reasonable price below elevation -230, and within its budgetary limitations. The lands that were in private ownership after that date are the lands that have created problems. Some owners, apparently presuming that Salton Sea was simply a dump for agricultural waste water from Imperial Valley, subdivided parcels of land around the periphery of Salton Sea. Many parcels were sold and improvements were made. Quite a number of these parcels of land, and the improvements involved, have been inundated. Some day they may be high and dry, with the Salton Sea far away. On the other hand, there may be more flooding. It is not in the nature of natural sinks that the level can be closely controlled if they are also the repository of flood waters.

Apparently, the greatest floods that modern man has experienced in California were the floods occurring in the winter and spring of 1861-62 (43). The Central Valley became a lake".....250 to 300 miles long and an average of at least twenty miles wide.....". After that flood, the Sacramento City Officials decided to make the second floors of the downtown buildings the first floors. There was so much mud and debris in the streets that this was the only reasonable solution. It was also in that winter that Goleta Harbor, near Santa Barbara, became a shallow lagoon with a sand spit across its mouth, because of the debris carried down by the local creeks (44). Also, that winter, the Santa Ana River, both in the Upper Basin of San Bernardino and Riverside Counties, and in the lower Basin of Orange County, drastically altered its course (45). Those channels have not changed since. These events are pertinent because the runoff from Coachella Valley's surrounding mountains, mainly the Whitewater River and its tributaries, created a Salton Sea that same winter (46). Various reports seem to put the length of that sea at something between 20 and 60 miles, but it dried up rapidly (2, 1). This event highlights the point that man does not, and cannot reasonably do so, control the level of Salton Sea. Obviously, ever since 1905, man's actions have affected the level of the Salton Sea. However, this does not mean that man has full control over the level. He cannot control sudden flood events, nor entirely the gradual lesser availability of water.

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contrast to the agricultural useage (use of water for cooling purposes is a consumptive use similar to agricultural use).

Any concept of appreciably decreasing the weathering process must be put into the category of hope, and not a reality. There is also the concept of storing salts on a river basin system in perpetuity. This may be desireable for the short term, but can be disastrous for the long term (greater than maybe 50 years). The only real long term solution to problems of salinity are to gradually move upstream for the source of supply, and to allow the lower rivers to gradually become more and more saline. In other words, get the salts to an ocean, or other sink, as rapidly as possible. --PILLSBURY.

Because of surface tail water, and subsurface drainage water from the Imperial and Mexicali Valleys, and because of natural flood flows, the Salton Sea never completely dried up after 1907. However, there is evidence that, in 1917, the Sea supported a good fishery (1). In 1932, however, the level of the Sea was apparently at about -245 feet, and was too saline to support much fish life. This changed as soon as the main All-American Canal was completed. The most important cause of the rise of the Salton Sea levels occurred because of better economic conditions, better farming and irrigation techniques, World War II, and following years. These latter factors contributed to the rise, as well as unanticipated heavy floods. The Sea level as of mid-March 1978, was at -228.3 feet although the usual summer drop is anticipated. This is the highest level since 1907.

With rise in water surface in the early 1940s, there was a great deal of dilution, and the Sea was again ripe for fish life. Mullet reappeared. Shortly after World War II, the California State Department of Fish and Game announced through the media that, because of the dilution, there could be at least 20 years of fish life, and that they intended to stock it with desirable ocean fish. They did, and the prophecy has been fulfilled, although today the salinity is in excess of 37,000 ppm as tds. It is known that, in the past when the Sea became too salty, the fish disappeared. That day may again be fast approaching.

There was a movement looking towards the dividing of Salton Sea into two bodies of water with a levee system (11). The least saline waters of New River, the Alamo River, and the Coachella Valley Stormwater Channel would flow into the first body of water. Then to keep the salinity in the first body rather constant, water would be released by gravity, or pumped as necessary, into the second body. The second body would be the sink where salinity could rise unchecked (11). Technically, the project is feasible, assuming that man has sufficient control to keep the level reasonably constant. The basic question is: Who would pay for this costly endeavor? It would not be reasonable to ask the farmers to pay who use it as a sink, which it naturally is. Since the sport fisherman who would benefit represent an infinitesimal portion of the total population, neither the state nor federal governments are anxious to pay. Who would pay?

There is one more matter that should be mentioned. Looking towards the mid-1980's when the Central Arizona Project will come on the line, California users of Colorado River water must learn to use a lot less. Even now, Imperial Valley farms, utilizing the more precise laser beam levelling technique, are rapidly grading their fields for "level irrigation". Level irrigation means that a large area is made precisely level. Highly efficient irrigation can then be accomplished by simply filling such basins rapidly, usually from several locations simultaneously around the levee periphery. The water, being shut off as it is being moved to the next such basin, is allowed to sink gradually. The technique is adapted to furrow irrigated row crops as well as all types of field and orchard crops. This provides for the elimination of tail water. The future can only bring less water into Salton Sea, and the level will probably start to drop. This will cause the salinity of the Salton Sea to rise rather fast, and will drain the few open ditches in Coachella Valley.

The existence of fish in Salton Sea will continue to be a rather temporary thing, as it always has been naturally. The same holds true for the District's open ditches. It does appear that we are reaching the end of a fish cycle.

D. Water Flow Through Unsaturated Soil

Plant roots require aerobic soil conditions to remain healthy. (A notable exception is rice, not grown commercially in Coachella Valley.) In other words, plant roots require a source of soil air, as well as nutrients and moisture. The movement of moisture in soil can be characterized as either saturated or as unsaturated (12). If saturated, the soil water is under a positive pressure, and there is no air, except for tiny bubbles of entrapped air that are not displaced (13, 14). With unsaturated flow, the soil water is under a negative pressure or suction. When water moves, it is sucked along by capillarity. Thus, the soil water exists as films around the individual soil particles, and as wedges between them. In this environment, there is always soil air, and the interface surfaces between soil and air are tremendous in area. Also, as soil dries out, the water is replaced by air. When there are changes in barometric pressure, the soil breathes. The same thing occurs with wind - the drag of air over the soil surface causes soil breathing. Thus, irrigation, and the subsequent drying out, provides a far superior environment than found elsewhere in nature, or in the works of man, for decomposition and oxidation of all exotic chemicals and other organic materials. This applies to all pesticides, the wastes of man and animals, and about everything else except salt and heavy metals. There is no other environment that can approach the decomposition capabilities of the unsaturated environment, and this is why ground water is normally free of pathogens.

One other thing should be mentioned in respect to the unsaturated flow of water in soils. When a large body of water is ponded for some period of time, the water table characteristically rises to the surface, and there is only saturated flow of moisture downward. On the other hand, with the irrigation techniques of agriculture in an arid environment, and with agricultural drainage, there is always unsaturated flow.

E. Nutrients in Soil and Water

Nutrients are those elements in salts that are absolutely essential for all plant growth. Photosynthesis, by which plants convert the energy of the sun into the organic matter that is required by all plant and animal life, is limited by the nutrients than can be obtained. Without the nutrients, there would be no life what-so-ever on earth.

There appear to be two objections to nutrients in water: (a) Nutrients encourage the growth of the blue-green algae on the surface of water bodies. These are the light weight algae that tend to form scum on the surface. This scum may be blown to the shores where its decomposition can create odor problems. (b) The green algae grow in the surface and near-surface waters, and, as they die and drop to the bottom, their decomposition robs the water of its dissolved oxygen (DO), creating an anaerobic condition not desirable for benthic animal life. The benthic life is often the food for fish, and sport fishermen want the environment optimized for the production of the fish that they desire to catch.

Some insight into these concepts is in order. Excessive growths of the blue-green algae probably should be avoided (47) because of the inhibition of diatoms, but the role of these algae in nature is to fix nitrogen from the atmosphere, thus enriching the nutrients available. (Nitrogen is the most common nutrient lacking in nature, applicable to all of the oceans, and to the greater part of the land.) On the other hand, the green algae serve to initiate the aquatic food web. Some fish are maintained by catching insects flying over the water surface, and by organic detritis washed into water bodies from land. But, most fish are dependent upon the aquatic food web. In this regard, Shapiro of the University of Minnesota (15) has demonstrated by tests using clear plastic bags suspended in an euthropic Minnesota lake, that the water where blue-green algae are dominant can be converted to aesthetically desirable green algae water by: (a) adding nitrogen compounds to the water, (b) adding phosphorous compounds to the water, and by (c) adding CO_2 to the water. The lack of CO_2 in eutrophic waters may be the key problem, but certainly nutrients were also needed with the waters Shapiro worked with.

If there is a lack of dissolved oxygen (DO) in the benthic waters, there would also be a lack of CO_2, because the aerobic decomposition of organic matter demands oxygen, and gives off CO_2. This gives credence to the concept of minimizing nutrients in waters to minimize algae, so there will not be dead algae to pile up on the bottom. On the other hand, if there is a good food web in the water, the benthic life is a vital part of that food web, and upon which many fish depend. Therefore, it is the DO of the bottom waters that needs correction, not the suppression of green algal growth. In particular, urban liquid wastes, even with considerable treatment, are low in DO and often still have some biochemical oxygen demand (BOD).

It should be pointed out that the effluent from tile drainage has passed through unsaturated oil with considerable degradation of pollutants, and is well aerated. This is generally not true with urban wastes. Even if these are run into percolation ponds, the water table can be expected to rise as a mound and to deny any unsaturated flow.

With irrigation of agricultural crops other than rice, there is always a layer of unsaturated soil that water must percolate through. That fact has given rise to a new method of treating the liquid wastes of the several types of animal concentrations (feed lots, dairies, chicken operations, hog operations, etc.) A large pit is dug into which the raw wastes are dumped or washed. The solids in those wastes seal the bottom and sides of the pit, preventing ground water contamination. When irrigation takes place, the wastes are pumped into the irrigation water in such manner as not to exceed 10 or 15% of the irrigation supply. There are a few crops that cannot be so irrigated, particularly root vegetables. However, it does put the solid and liquid pollutants in the ideal environment for decomposition and elimination. The nutrients fertilize the crop, and the decaying organic matter improves the structure of the soil. With irrigation, there must be flow through unsaturated soil, and additionally the soil dries out between irrigations. Human sewage is generally less concentrated than animal sewage, but there is no reason why this technique would not also be suitable for human sewage. The only treatment would probably be sand removal and grinding of the influent. There is no doubt that advanced tertiary sewage treatment, followed by modest chlorination, has corrected many problems, except when there are outages - and outages are common - but the above is an alternative suitable for urban developments in or near irrigated agricultural land.

Finally, in recent years there has been a tremendous amount of federally sponsored research on ways and means to substantially reduce the amounts of nutrients in waste waters. For some years the effort was concentrated on phosphorous, and present efforts have concerned nitrogen (33, 34, 35, 36, 37, 38, 39, 40). The value of such massive concentrated research is questioned, as well as the concern about nutrients in waste waters. Viets and Wadleigh present a well balanced view on that and other items. (41).

F. Pesticides in Soil and Water

Under nature, predators and the food or nutrient supply keep the insects, birds, animals, fungi, diseases, and weeds in check. Man's agriculture has drastically changed all that, having drastically increased the food supply available for all types of life. Because of agriculture, we have had a dramatic increase in pests of all types that nature previously kept in check. A few examples:

--The periodic swarms of locusts that sweep broad paths through nations, destroying all vegetation in their paths.

--The monkeys in India that destroy much of each crop.

--The coyotes in the United States where they find lambs to be "sitting ducks" as a food supply, in comparison with the natural fleet animal life. The population of coyotes has probably at least tripled in this new environment.

--The insects that plant their eggs in apples, beans, grains, dates, and many other crops, so that the larve, when they hatch, consume a significant part of the crop and/or make it less palatable.

--The birds that, typically, do not eat all of some crops, but do eat holes in fruit, grapes and other crops, making the fruit less palatable as well as greatly decreasing yields. Birds partially compensate by eating vast amounts of grubs and worms.

--The weeds that will rob almost every plant crop of nutrients, moisture, and sunlight unless diligently controlled.

Man, dominantly in the United States, has been able to control, but never eliminate, all of these pests by the use of pesticides. This has enabled our nation to lead the world, generally, in agricultural productivity. There has been a several fold increase in the quantities produced, and an immeasureable improvement in quality. It is in agriculture alone that there is any semblance of "Balance of Trade", greatly lessening our devastating inflation. This inhanced productivity has substantially raised standards of living, and has given man a tremendous amount of leisure time.

There has always been a scientific endeavor in the United States to develop "biological controls" for all types of pests. This is parallel to, and well coordinated with, the pesticide approach. There is always the hope that biological controls will minimize the pesticide approach, but biological controls are slow to develop, and have many shortcomings. Pesticides are expensive to develop, and expensive to apply. No farmer wants to use them, but must use them if they are to stay in business. Further, the pests controlled by a particular pesticide generally become ineffective after about 10 to 20 years, because the pests become immune. That means a constant struggle to develop new pesticides to which the pests are not immune.

There has been another development, starting about 25 years ago and subsequently accelerated, that has added a new dimension to the detection of pesticide residues throughout the environment. This development has been the discovery and improvement of sophisticated equipment to indirectly determine trace amounts of pesticide residues, and other chemicals, in several parts of the environment. Several types of recording chromatographs probably dominate this field. The amounts that can be detected are so small that they must usually be reported in parts per billion (ppb), in parts per trillion (ppt), or in equivalent metric units.

These new techniques have opened a whole new realm of somewhat dubious information. Laboratory experiments are set up under which mice or other animals are fed a diet with some of the chemical added to the food to see if the chemical might be carcinogenic. The problem is that the concentrations of the chemical in the food is commonly at least several hundred times the concentration found in water, in the flesh of fish, or in other parts of the environment being tested. To say that the tiny amount found "might" be carcinogenic may be technically correct. However, it is really exploiting man's fear of cancer, and is hardly ethical.

Particularly with the long-lasting chlorinated hydrocarbons such as DDT and chlordane, there has been a surprising lack of proven harmful effects to humans. While it might be true that there have been adverse health effects to a few people, those same pesticides have been effective in preventing malnutrition and starvation deaths to many millions of people throughout the world.

There is the charge that, while pesticide applications may be necessary from time to time to preserve some crop, farmers have a tendency to undertake pesticide application on a routine basis whether or not really needed. Such practice would put more residues into the environment than is absolutely essential. Since the costs of spraying or dusting are among the highest in farming, this charge is questioned. While a farmer may routinely undertake spraying or dusting, it is certainly based on good experience that tells him, if he doesn't, he will not have a crop.

Another problem with application of pesticides, particularly insecticides, pertains to the use of high pressure sprayers. With such a technique, it is inevitable that there may be many micron-sized droplets formed. These will not settle out, but drift around in the atmoshphere until they grow substantially in size by one means or another. Research entomologists have long been concerned with this problem, and have studied application with a foam and at lower pressure. Since there has not been a shift to such methods, it is assumed that the research has not been successful.

Imperial Valley soils are predominantly very fine textured Colorado River sediments. Infiltration rates of irrigation water are thus slow, and runs of up to ¼ mile are common. The resultant large sized fields are thus well adapted to aerial application of pesticides. In contrast, the permeable soils of Coachella Valley require that irrigation runs be quite short, and this is accentuated by the far lower rates of flow inherent with a pipe distribution system in contrast with Imperial Valley's open ditch system. For these reasons, drift of sprays and dusts into the drainage ditches can be expected to be a far greater problem in Imperial Valley than in Coachella Valley. Thus, in the absence of good technical data, it must be presumed that drift of sprays and dusts into drainage ditches is not a serious problem in the Coachella Valley, and that the greater part of any pesticide residues found in drainage ditch waters are more likely from surreptitiously discharged tail water than from any other source.

All in all, use of pesticides has been remarkably free from proven harmful effects. When there have been problems in isolated instances, there were usually reasonable preventive measures that could have been taken. While a few lives would be saved, pesticides do prevent malnutrition and starvation deaths of many millions of people throughout the world. There is need to put things in proper perspective.

The significant fact is that the vast interface areas between soil water and soil air existing with unsaturated flow of water in soil provides the best possible environment for the decomposition of pesticide residues, whether or not they are truly harmful to the downstream environment (16). The combination of periodic irrigation with tile drainage provides this environment (16).

G. Irrigation Methods

Irrigation methods can be classified as surface, sprinkler, and drip-trickle. Surface methods are where water is run over the surface of the soil itself in order to achieve coverage of the total land area required. With sprinkler irrigation, water is conveyed in pipes with final application through the air from the sprinklers, or from perforations in the conveyance pipe. With drip/trickle irrigation, the water is conveyed in plastic tubing to each spot where it is applied through emitters. With small row crops, a porous tubing may be used, so that there is a line of soil wet. The drip/trickle system is best known simply as drip irrigation, but the term "drip/trickle" is often used because the water usually emerges as a trickle rather than as a drip. The term "drip irrigation" will be used herein. (Delivery and use of irrigation water is governed by Ordinance 958, Exhibit E-9.)

1. Surface Irrigation

Sometimes surface methods are classified as either furrow or flooding methods. Row crops are usually irrigated with furrows. Furrows, with row crops, are normally 2 to 4 feet apart, so there is usually, in Coachella Valley, sufficient lateral movement in the first foot or two of depth of soil so that below that depth downward movement in essentially the same as though the entire area had been flooded. Where because of either spacing of furrows or nature of the soil, the dominant moisture movement is lateral rather than vertical, salts will simply move laterally with the water, and accumulate at the outer fringes of the wetted zone. To maintain rootzone salt balance, the salts must be leached vertically downward to below the rootzone.

Another problem with furrows is that, to get the water to the ends of the runs in a reasonable length of time, the furrows have to be on a reasonably uniform slope usually between 0.2 to 1.0% (the latter is a 1 ft. vertical drop in 100 ft. horizontal). Usually, when the water reaches the lower end of the run, there has not been enough penetration of water into the soil all along the furrow for an adequate irrigation. There can be expected to have been more penetration near the upper end, and near the lower end, than in the middle portions. This means that water must be kept flowing all along the run until all portions have adequate penetration. An old method of accomplishing this was to cut back the flow rate in each furrow sufficiently to just maintain flow to the end of the furrow. Because of high labor costs, this method is rarely used today. A second method, and one commonly used in many areas, is simply to let waste water run from the ends of furrows until adequate penetration has been achieved. This is the production of tail water. A third method is to dig one or more sumps at the low ends of each field, and to pump that water back to the supply through a pipeline. The pump can be automated by float control in the sump. This technique is being used increasingly , but does entail use of more energy.

A surface method long used for alfalfa, and other forage crops, is the border-strip method. With this, there is a definite slope in the direction of run so that water flows readily.

The strips are level across the slope so that water spreads evenly over the width of the strip. There is usually some cross slope, so the elevation difference, up to about 0.2 ft., is absorbed in the border itself. The borders are low broad levees, such that the mowing and other equipment can easily cross over them. Border strips have the same tail water problem that characterize furrows, and the solutions are the same.

There are several basin types of flooding irrigation so designed that each basin is level or nearly so. Each basin is filled to the depth desired with the entire flow available from some type of a pipe system, or from a ditch, and then the next basin is irrigated, and so on. Essentially no tail water is generated with such basin irrigation. Contour basins are where levees are constructed along each 0.2 ft. difference in elevation, and cross levees constructed as needed to keep the area of each within limits. There are also various types of rectangular basins, as adapted to the soil and topography of the land, which generally do not produce tail water.

The most recent innovation is the adaptation of laser beam technology to land levelling. With the greater precision achieved at reasonable cost, it is now feasible to make each field absolutely level. Furrow irrigation of row crops, border strip irrigation, and the usual basin irrigation can be adapted to this. If large flows can be made available, as in Imperial Valley, each basin can be quite large, with water often being admitted at several points to each basin to minimize erosion. Thus, basins are quickly filled, and then the irrigation moved on to another basin while the water gradually infiltrates.

2. Sprinkler Irrigation

Sprinkler irrigation is being used more and more in Coachella Valley, although most irrigation is by surface methods. Sprinkler systems can be classified as portable or permanent. The former use quick coupling aluminum pipe, and are moved after each setting. The latter can use plastic or steel pipe, and are simply turned on for each irrigation, and shut off when the irrigation is completed. Such systems can be partially or fully automated. A variation that comes between portable and permanent systems is the "solid set" system. With these, a typical portable system is set up in a field as the crop is planted, and is not moved until just before the crop is harvested (42).

The sprinklers used by agriculture are almost always of the slow-rotation type (often called "Rain Birds", but since all patents have expired, essentially all manufacturers produce slight variations of them). The advantage of the slow rotation type is that the maximum area per sprinkler can be covered, and low rates of application are feasible. Originally, most slow rotation sprinklers had two nozzles. Today, these are only used for portable systems in nations where labor is cheap, and where soils are highly permeable. Such systems are moved relatively frequently.

A drawback of sprinkler irrigation is that the sprinkler patterns are badly distorted by wind. Generally, irrigation should be avoided when winds exceed about 5 miles per hour (MPH). Because winds often do not persist in one direction for 24 hours, the once-per-day move systems are preferable where wind is a problem.

There are undertree sprinklers with special low-pressure slow-rotation sprinklers in each middle between 4 trees. These are generally portable systems, often hose-drag, the patterns are better protected from wind, and the uniformity of application is not as important as with most overhead systems.

There are a number of types of travelling sprinkler systems. The most common is the center pivot system, designed to cover a circle bounded by the square encompassing 160 acres. There are such systems with added sprinkler guns, presumably designed to fill in the four corners of the square. These are rarely satisfactory.

No center pivot systems have been observed in the area served with Colorado River water. However, there are said to be a few such systems, each served by a well near the center pivot, in the Upper Valley.

There are also travelling sprinkler systems (parallel move) developed to cover a rectangular area, but these have never been too popular. There are also roll-move systems with the pipe mounted as axles of big wheels. When the water is shut off with completion of each run, the pipe automatically drains. The unit is then moved laterally to a parallel new position by a lever-ratchet devise, or by a small gasoline engine. As soon as moved, the water is again turned on. There are also two units on wheels, these require an adjacent open field. The unit is towed by tractor longitudinally into the open field, and then towed back for a new position. Finally, there are relatively small drag units, usually on hose for undertree use. These are dragged by hand after each setting.

With all wheel-move systems, the soil during and right after irrigation must be firm so that the units can be moved easily. No wheel move system should be used where the soil is soft or spongy during or right after irrigation.

Permanent or solid-set sprinkler systems are often used for frost protection. Usually, the pressure should be around 45 to 60 pounds per square inch (psi) at the sprinkler, with the rate of application not over 0.2 in./hr. Frost protection is attained by the freezing of the water droplets on the plant and/or the fruit.

Sprinkler systems commonly have devises so that soluble fertilizers can be injected into the water. Also, in Europe, it is common to have fungicides applied through the system. Even insecticides have been so applied, but regulatory agencies generally frown at the practice. All pesticide application by sprinkler systems is generally outlawed by regulatory agencies in the United States.

Sprinkler irrigation provides an excellent mechanism for leaching the soil rootzone of salts, since the movement in the soil throughout the field is vertically downwards. When drip irrigated soils must be leached, sprinkler irrigation provides the best mechanism for this.

With sprinkler systems it is almost always necessary to use energy for pumping, except where water is provided under adequate pressure. Most overhead systems require a pressure of at least 40, and up to 65 psi. Undertree systems can utilize a pressure in the range of 10 to 20 feet of water.

Sprinkler irrigation is rarely used for the growing of seed crops because it tends to create a more humid micro-environment in and around the plants, conducive to more disease which adversely affects the seed crop. Crops grown for seed are almost always surface irrigated. (California's dry summers make it a favored location for growing seed crops.)

Finally, with good design, and good operation, sprinkler irrigation should be able to achieve about 80% application efficiency. This compares with 40 to 70% application efficiency for surface methods. And, considering the variability and stratification of Coachella soils, a top application efficiency with surface methods would rarely exceed 60%.

3. Drip Irrigation

The concept of drip irrigation is that, if one keeps the most active portions of the rootzone with moisture at low suction levels by frequent applications, it is not necessary to wet too high a percentage of the total soil rootzone. With crops such as trees and vines, there are generally 2 to 4 drip points per plant, and with small row crops a type of porous hose is used. With the latter, the lateral hose is generally discarded after each crop, although it has been used for two crops. At each drip point, the soil wet is generally shaped something like a carrot - with some soils, a rather thin carrot, and with other soils, a rather fat carrot. With the stratification generally prevailing in Coachella Valley, the "carrot" must be expected to have a most irregular shape.

A big advantage of drip irrigation is that much of the soil is not wet at all, thus decreasing evaporation from the soil surface. This is important in spring and fall with deciduous crops such as grapes. It is important with young plantings whose canopy of leaves does not intercept most of the sun's radiant energy. It is not important where there is essentially a full canopy of actively transpiring leaves. (In Israel, many mature plantings of citrus are being converted from drip irrigation to undertree sprinkler irrigation.)

If drip irrigation emitters are left on for too long a period, there will be a great deal of movement vertically downward below the rootzone, without putting much more water out laterally within the rootzone. To obtain practical information on how well drip irrigation works at a given point, there should be some digging after irrigation to determine the shape of the "carrot".

III. AGRICULTURAL DRAINS IN COACHELLA VALLEY

A. History

The history of agricultural drainage in the Coachella Valley has its roots in the need for irrigation water. The Coachella Valley County Water District was formed in 1918 because it was well recognized that there must be a new and larger supply of water than could be made available from the groundwater resource. Further, it was recognized that far more water was being extracted than replenished.

Sometime before 1932, R. W. Blackburn, President of the District, began contacting people of the University of California, Agricultural Experiment Station, and the U. S. Department of Agriculture, to get irrigation studies started in Coachella Valley. This was intended to provide information on the amount of water required. His final negotiations were with Professor Frank Adams at the University of California in Berkeley, and with Mr. Harry Blaney, with the USDA in Los Angeles. The final agreement was that the University would provide a Junior Irrigation Engineer to initiate the irrigation studies, and that money would be made available by the USDA for labor and supplies. Arthur F. Pillsbury, then working for the Turlock Irrigation District, was hired after clearance with that District. Frank Adams decided that Art Pillsbury should spend a few weeks getting acquainted with the field and laboratory work underway at Davis, and then to spend a few days with Professor S. H. Beckett at the Citrus Experiment Station in Riverside before going to Coachella Valley. So as not to delay start of irrigation studies in Coachella, C. V. Givan of his staff was dispatched to Coachella to undertake the necessary reconnaissance work. Pillsbury arrived in Coachella sometime in February 1932. He was provided with desk and drafting space in the office of the Coachella Valley County Water District, and with laboratory space at the USDA Date Experiment Station near Indio. Towards the end of the year there was question, because of the depression, whether or not the studies could be financed during 1933. Possibly the recall of R. W. Blackburn in 1932 had something to do with it. While Pillsbury was home in Berkeley for Christmas, the decision was made to close out the Coachella work.

In 1935, Sam Beckett, who headed the irrigation research at the Citrus Experiment Station, and the irrigation teaching at UCLA, retired. Professor Martin R. Huberty, who had been stationed on the Davis campus, was selected to replace him. Because the work in Southern California needed expansion, a separate Division of Irrigation Investigations and Practice was established at Riverside and Los Angeles. This required that a younger man accompany Huberty. Pillsbury was selected, and proceeded to close out an irrigation project that he was finishing in the Hollister area. Pillsbury then drove south to Riverside, which Huberty had selected for the original headquarters. The headquarters was moved to UCLA in 1939 because that, overall, would involve considerably less travel.

This is the background of the circumstances that permitted resumption of the Coachella irrigation studies in early 1936, entirely under University sponsorship. That same year, Huberty decided that, with the imminent importation of Colorado River water, a pre-importation study of the hydrology of Coachella Valley would be of great importance later. He persuaded Dr. V. P. Sokoloff of the Citrus Experiment Station to add chemical expertise to the study; so Huberty, Pillsbury, and Sokoloff made up the team.

A large part of the irrigation studies involved sampling to a maximum depth of 18 feet with the Veihmeyer soil tubes. The primary purpose of this was to determine the rate of moisture loss at the several depths between irrigations. This work revealed that, because of discontinuous and irregular stratification, temporary semi-perched water tables tended to form immediately after irrigation in the interface of a layer of silt and clay dominated soil over a layer of sand. (As used herein, a "perched water table" exists when there is no hydraulic connection between that water table and a deeper water table. With a "semi-perched" water table there is continuous gradual downward percolation below the water table, but at some depths the flow is unsaturated.) This plagued the soil moisture studies, necessitating frequent reconnaissance work to find locations where the problem was minimal, and to discard records which indicated the possibility of continued downward movement of moisture throughout the period between irrigations. The results of the irrigation work were published in 1941 (6). What is important here is that the temporary semi-perched water tables indicated the near certainty that drainage problems would develop quite rapidly after Colorado River water was imported. This finding was reinforced by the findings of the hydrology study (2).

The USDA was busy, about 1938, in establishing its U. S. Salinity Laboratory in Riverside. Not too long thereafter, the Laboratory hired J. E. Christiansen to be its Drainage Engineer. Christiansen had long been on the staff of the U. C. Division of Irrigation Investigations and Practice at Davis, and had worked both with Huberty and Pillsbury. It was natural, then to informally involve Christiansen with the preliminary efforts on the potential drainage problem. Mr. E. M. Romberg was then General Manager of the District, and was concerned that the steps that should be taken be taken prior to actual importation of Colorado River water. A few years thereafter, possibly because of budget or procedural problems, the Salinity Laboratory decided that it needed to formalize the cooperation with the District and the University. The University agreed to go along with this formality, and it was accomplished in 1945 by a Memorandum of Understanding. Because of the involvement of the Bureau of Reclamation in planning the distribution system, and its desire to be involved with the drainage program, the Bureau was formally made a drainage cooperator in 1948. About the same time, the District and the Bureau had concluded negotiations whereby the District assumed all responsibility for all drainage construction, but with the Bureau participating in all drainage studies.

Another question was raised by Romberg during the early stages of the informal cooperation on drainage studies (before 1945), at that time there were many comparatively small and isolated irrigated areas around the Valley. At no place were there any ditches to carry off any tail water that might be generated. Generally, the farmers were desperate for enough water, and used every bit they could get without any wastage. If there were a few who did generate a little tail water, it was just allowed to flow over vacant downstream land. With the importation of Colorado River water, more or less contiguous plantings would develop, and farmers were visualized as demanding ditches into which to dump tail water, as in all other irrigated regions. After much discussion, it was agreed that the farmers could avoid tail water, and that the District would not construct such ditches. This policy would make irrigation a little more expensive for the farmers, but would pay off in later years. No ditches deliberately dug for tail water discharge have ever been built. Today, there are stormwater channels and open drains that can be used surreptitiously for tail water disposal, and it is probable that some farmers do so.

Within the above framework, there appeared to be two possible methods to accomplish agricultural drainage. One would be to have a network of relatively shallow wells, some of which could be discharged, at least part of the time, into the distribution system, so diluted as not to affect salinity to an appreciable extent. If of high salinity, the effluent could be piped to a stormwater channel. The other method would be regular tile drainage. The farmers would be responsible for installing the farm tile, and the District to install the conveyance pipe to pick up drain effluent from the low corner of each 80 acres.

Techniques for water table observation. The first order of business, in any event, was to develop a technique for quick observation of the water table, and the changes in piezometric pressure with depth. This was necessary to evaluate the performance of drainage wells of tile drains, and to monitor groundwater conditions throughout the trough of the Valley. A jetting technique was suggested by a Mr. James I. Easley, manager of the farm where arrangements had been made to drill an experimental drainage well (17). Later, in the process of developing a rig to make the jetting technique quicker, and not requiring such a large crew, a vibrating method was tried. This was not satisfactory. Therefore, a mechanized technique was developed to imitate the up and down hand technique originally suggested by Mr. Easley (18). This rig was highly successful, and eventually resulted in the installation of a network of piezometers throughout the trough of the Valley on a half-mile grid. This also permitted evaluation of the effectiveness of all experimental drainage wells, and of drain tile installations.

The U. S. Bureau of Reclamation came into the picture when the experimental drainage well program was underway, but there was no network of observation wells or piezometers throughout the Valley. The first suggestion of the representatives of the Bureau was that they had a Failing hydraulic-rotary drilling rig, with a core barrel attachment, that was just finishing an assignment elsewhere, and could be on the job in Coachella in short order. It would drill 6 inch diameter holes, to be cased with 2" I.D. asbestos-cement pipe (AC pipe), and gravel packed. The representatives claimed wonderful results with this rig. The bottom 5 to 10 ft. could be perforated with ¼ in. drill holes. Decision was made to utilize this rig for a 2-mile grid of wells in the trough of the Valley, and 42 of them were drilled. These could be compared with adjacent piezometers, and offered the possibility of obtaining core samples, and of obtaining water samples for chemical analysis.

The observation wells. The cores from the Failing drilling rig were good for silt and clay, but essentially no sample was obtained in sand or gravel. As to water samples, the first thing discovered was that the chemical characteristics were altered by the AC pipe, and that pumping at about 2 gpm for 6 hours was necessary to overcome this. Only 19 wells could be pumped by suction; so a jet pump was developed and constructed to pump the others. Part of those not pumped by suction were essentially too dry or had too little water flowing into them to obtain a good sample. The water sampling program was not very successful. For the Failing wells as a whole, they cost $1.50 per foot for drilling and materials. With all of that cost, they did not add materially to the study. In all, 42 had been drilled, and there was no desire that the Bureau return the rig to the Valley.

The piezometers. In contrast to the observation wells, the piezometers were highly successful. Each one had to be developed to remove drilling mud that had to be used in coarse sand, and to assure good hydraulic contact with the ground water. This was done with a small hand pump with a length of plastic tubing attached to it. First, a jet of water was directed to piles of silt and clay put around each piezometer, so as to fill and seal the annular space between soil and pipe. Then, the tubing was inserted to about the bottom of the pipe, the hand pump operated as necessary to bring soil and mud to the surface, and to open a small annular hole at the bottom of the pipe. The tubing was then quickly withdrawn, and the water level sounder inserted. The flushing out would have raised the water level in the piezometer, and the rate of drop found with the sounder was the evidence of good hydraulic contact with the soil water.

The problem of obtaining good stratigraphy with the Failing rig has been mentioned. While somewhat qualitative because there were not exact textural correlations, the stratigraphy (or logs) obtained with the jetting rig were most useful, and far superior (18). Because the stratigraphy did vary so much from location to location, its usefulness was somewhat limited, but it did serve a most important function.

Studies of drainage wells. By putting several piezometers at each location, each to a different depth, information was obtained as to vertical hydraulic gradient at that location. Such groups of piezometers were placed at various distances radiating out from each experimental well. These permitted determination of the hydraulic efficiency of the well in removing ground water from aquifers at several depths.

An hydraulic rotary drilling rig appeared to best suit the conditions for a drainage well in Coachella Valley. Therefore, the District, with the approval of the Drainage Cooperators, engaged a commercial driller, and eventually two wells were drilled. Drilling technique, and screens used for the second well, were varied to overcome problems with the first well. Finally, it was concluded the good hydraulic efficiency could not be obtained for the 0 to 50 feet depth, but good efficiency was readily obtained for depths over 50 feet. 100 feet was the maximum depth of well attempted.

Next, well points were obtained to explore the possibility of pumping only from depths less than 50 feet. Well points are designed to be driven in, but with the sands found in Coachella Valley, driving did not work. Therefore, a jetting technique was developed, and the well point was inserted into the hole after jetting. This did work, and several trials with well points were made. While nothing spectacular was learned, there was sufficient encouragement to try a dug well in the Oasis area, the most likely area for wells to function satisfactorily for drainage purposes. Therefore, well number 7 was dug with a clamshell, and large diameter concrete pipe was placed vertically as soon as the water table was approached. Thereafter, digging was from within that "casing". Controlled pumping after completion indicated that the well would be a good producer, but, unfortunately, maximum pumping was undertaken before the measures planned to prevent caving were completed. The well suddenly failed, material from outside the casing pushing up inside of the casing. Despite everything done thereafter, the well could not be made to produce a good flow. However, from piezometer information obtained, the indications were that drainage by pumping would not affect the water table over a sufficiently large enough area to make it competitive with tile drainage. Therefore, no more explorations with pump drainage were undertaken.

<u>The piezometer network</u>. As previously mentioned, the piezometer network was established on a half-mile grid throughout the central trough of the Valley, where it appeared possible that drainage problems might arise. The depths of individual piezometers in each cluster was determined by the stratigraphy obtained with the first, which was always the deepest. If the depth-to-water condition so indicated, the shallowest was about 10 feet below the ground surface. When rising ground water so indicated, new, shallower piezometers were later installed as water levels rose. The piezometers normally, were read once a month, but, where the water table was rising rapidly, they were read once per week.

This schedule permitted each landowner to be notified when the water table under his land approached 10 feet from the surface. Of course, it was not probable that there needed to be drainage at this depth, but the early notification obviated the need for installers to try to work in saturated soil, which is both costly and unsatisfactory in trying to maintain grade. Further it gave the landowners time to get the contractor scheduled for the drainage installation. Also, the District used the information to schedule placing of the drainage collection system, which had to be completed to the low corner of each 80 acre parcel when the farm drainage work started. This arrangement worked quite smoothly and problems of waterlogging and salinity were generally prevented before they occurred.

Design of tile drains. Equations have been developed that permit a rational design of tile drains (19). These require determinations of the hydraulic conductivity of the soil and are generally undertaken utilizing an auger hole technique. A number of such determinations were made by the Drainage Cooperators, and those showed conclusively that hydraulic conductivity was so extremely variable that a rational design would not be effective. The policy, then, was to recommend to farmers that their tile lines be to a minimum depth of 6 feet, (later increased to 7 feet), and that the spacing between laterals be at the widest probable range of adequacy. Then, if drainage was not fully adequate, they should plan to "split the lines", i.e., install new laterals half way between existing laterals. Splitting of the lines seems to be still going on, here and there.

Demonstration of tile drainage performance. There was one farmer in Coachella Valley fairly close to the Coachella Canal who had long been short of well water. Under this inadequate irrigation regime, another project (6) just happened to have shown that part of his land had a water table depth of 7 to 9 feet below the surface. In 1948, he had arranged to install a temporary pipeline of his own up to the Canal, which had just been completed. This enabled him to have an adequate supply for the first time. Very quickly therafter, some of his orchard trees began to show distress, and the area coincided with the earlier area of high water table. The cooperators agreed to install a small network of piezometers to learn where the water table was. Water table contours drawn on the basis of this information clearly outlined the problem area. Some deeper piezometers jetted in for information on stratigraphy clearly indicated that pump drainage would not work here, even though the pump drainage studies had not been started then. At that time the Cooperators were not sure if there could be a rational design, so simply planned a skeleton tile drainage network, and the owner was advised that he probably would later have to have closer spacing of laterals. The owner engaged a drainage contractor from Imperial Valley, who installed the skeleton network of tile drains. This system, as indicated by the piezometers was most effective, although there was indication that performance would be better with closer lateral spacing.

Efficiency of tile lines. Quite a few farm tile systems did not function as well as they theoretically should, and most of these problems came to the attention of the District. The District referred them to the Drainage Cooperators. Generally, when this occurred, piezometer evidence showed that the water level in the filter material around the tile was far higher than the water level in the tile. Wetting expansion of the tile itself could have tended to close the joint openings. This was investigated (20), but found not to be the problem. Inspection of the tile joints showed them to be filled with relatively fine soil and sand, which should have been excluded by the filter. The pit run material selected for the filters by the contractors does generally function as a the installing operation, small piles of filter material are scattered along the route of the tile machine, to be picked up with a scoop as the installation progresses. Invarably some soil is picked up with the filter material. Both the contractors and the farmers know of the importance of having clean filter gravel. Also, in Coachella Valley, a true filter, rather than simply an evelope, is required. It should about conform to the ASTM specifications for concrete sand (21). But, this is an area of contract between the contractor and the farmer, and the District has no control. Incidently, there is further information now available on drain tile performance (22).

Reclamation of saline lands. The importation of Colorado River water does mean, for purposes of economy, that the area served must be contiguous rather than to have the previous rather isolated islands of irrigated agriculture. This meant that the dominant area of salt affected lands in the central trough of the Valley should be reclaimed. The Drainage Cooperators undertook studies to determine how this might best be done (23). It was found that it took about one foot depth of water to remove 80% of the salts from each foot depth of soil. Where there was also high boron, it would take about three times as much water for similar reclamation. The District did set up special water rates for reclamation. There had been suggestions that periodic flushing might remove part of the salts, so that these salts would not have to be moved through the soil profile, as with leaching. It was found that, although salt concentrations were far higher at the surface, and that these could be removed by flushing, the extra effort required for flushing did not remove enough of the salt throughout the profile to make it worth the effort (24,23).

Demonstration of tile drainage and reclamation. There was a highly saline and sodic soil area with dominantly fine textured soil of the Woodrow series in the lower Oasis area. There was a drainage contractor who said that he would buy the land, and go to the expense of reclamation, if the Drainage Cooperators would advise procedure, and monitor the work, and if the District would provide the leaching water. The cooperators agreed to go ahead, as did the District. First, a series of hydraulically isolated plots were established to obtain a perspective on procedures. When this was done, the entire field was to be reclaimed following the procedure that had been demonstrated by the plots: (a) Ditches were dug to permit preliminary drainage before tile drainage was undertaken. The water table was so high that, without this, tile could not be installed. (b) When the water table had lowered sufficiently, tile drains were placed throughout the entire field. The field was deep plowed to break up the great amount of stratification above the tile. While a little deeper would have been preferable, the owner was only able to deep plow to 4 feet. (c) Finally, the land was ponded until sufficiently reclaimed to plant a salt tolerant crop. (d) The owner completed reclamation growing that and subsequent crops.

B. The Existing System

For over 12 years now, there have been some 35,000 acres served by well over 2,200 miles of farm drains. To serve this area, the District has installed 163 miles of pipe collectors

TABLE 11

SALT BALANCE FOR COLORADO RIVER WATER IN COACHELLA VALLEY, CALIFORNIA

(From records of the Coachella Valley County Water District)

Year	Total Discharge of Drainage Water Ac. Ft x 10^3	Total Salt Movement in Tons x 10^{-3} Inflow	Outflow	Balance
1970	127.0	358.8	331.8	+ 27.0
1971	134.0	357.3	370.9	- 13.6
1972	146.1	381.3	359.8	+ 21.5
1973	152.8	395.8	358.6	+ 37.2
1974	148.3	423.4	385.8	+ 64.6
1975	164.4	434.0	483.1	- 48.5
1976	167.7	400.6	364.4	+ 36.2
			NET	+124.4

NOTE: In Table 4 of publication no. 22, salts in the regulatory waste were included in both inflow and outflow. Those salts are excluded above, but it makes no difference in the balance.

for the farm systems, and 21 miles of storm drains, and other open ditches to connect the collector system to the Salton Sea not including the Coachella Valley Stormwater Channel. Because of the high level of the Salton Sea, a number of booster pumps have had to be installed at the ends of the collector pipes, particularly in the area southeast of Mecca, to get the water into the ditches. The map (CVCWD Map No. 46-B) shows the pipe collector system (solid lines) and the ditches. It now appears that the drained area is almost in a state of equilibrium, i.e., drainage is almost adequate to provide salt balance for the area within the Colorado River service area (22, 25). The District maintains complete records of Colorado River water and salts into the Valley, and water and salts into Salton Sea. Putting the critical parts of these records into the same format used in Table 4 of publication No. 22 (See APPENDIX A-Bibliography), the salt balance trends for the period of 1970 to 1976, are given in Table II, following page 3-7.)

In the earlier years of tile drainage in the Valley, there was a great deal of leaching to remove long stored salts. Thus, there was a "mining" of salts. In any salt management program, there must be expected to be some rather permanent precipitation of calcium carbonate, magnesium carbonate, and calcium sulfate. Such deposition does not affect salinity because those salts are too insoluble to create salinity problems (26). This means that there can be salt balance without the data showing it. However, there does not appear to be much such deposition in Coachella Valley.

C. Physical Characteristics of Water in Open Drains

Only monthly records of temperature are made of the physical characteristics of water in open drains. The only other measurement that might be considered of importance is turbidity.

The water emerging from tile drainage collectors is almost invariably crystal clear. If there should be any turbidity for a short period of time, it would mean that some farmer was experiencing a filter failure at some spot in his tile drainage system. This has happened, particularly with "subbing in" operations to consolidate the backfill over a new tile system. This does show up on the farm over the tile line of concern. For the owner's own good, he must take immediate corrective action.

Many open drains also serve as stormwater channels. It would be expected that, during floods, there would be considerable turbidity. This is a natural phenomenon that is not under man's control. However, flood control activities normally involve efforts to detain the flood flows, and this provides for the settling out of some of the sediments before the ditches are reached.

Another cause of sediments results from gopher activities on the banks of the drains. The sediments involved tend to dam the ditch, and, when this occurs, there is no alternative but to dredge to remove the dams. This is necessary so that the drains will still have the gradients to serve their drainage function, and so that the drains will remain a good habitat for the vegetation eating fish that the District periodically plants. The same thing holds for the sediments caused by floods.

TABLE III

COACHELLA VALLEY COUNTY WATER DISTRICT

DRAINS TO SALTON SEA - TEMPERATURES - FAHRENHEIT DEGREES

1977

NAME OF DRAIN	MONTH J	F	M	A	M	J	J	A	S	O	N	D	MIN.	MAX.	AVG.
F Channel	75°	78°	75°	79°	80°	92°	85°	98°	93°	92°	82°	72°	72°	98°	83°
Grant-Oasis	73°	73°	69°	71°	70°	79°	78°	87°	87°	84°	78°	72°	70°	87°	77°
"E"	71°	75°	72°	72°	73°	83°	90°	78°	87°	84°	78°	73°	71°	90°	78°
Avenue 83	71°	72°	71°	70°	72°	76°	80°	82°	83°	82°	80°	75°	70°	83°	76°
"D"	60°	65°	76°	73°	80°	85°	90°	89°	93°	75°	72°	64°	60°	93°	77°
"C"	53°	65°	76°	73°	85°	95°	95°	89°	75°	74°	72°	66°	53°	95°	77°
Lincoln-Oasis	65°	72°	73°	74°	75°	85°	87°	94°	79°	78°	78°	75°	65°	94°	78°
Avenue 79	67°	73°	75°	77°	78°	85°	87°	94°	82°	82°	80°	74°	67°	94°	80°
"A"	70°	79°	78°	76°	78°	81°	83°	85°	90°	84°	84°	81°	70°	90°	81°
Avenue 76	69°	70°	69°	71°	70°	75°	78°	83°	81°	81°	77°	72°	69°	83°	75°
Avenue 74	66°	70°	66°	75°	68°	76°	84°	83°	85°	82°	80°	72°	66°	85°	76°
C.V.S.C.	58°	63°	63°	63°	67°	74°	82°	85°	77°	73°	76°	63°	58°	85°	70°
Johnson	68°	63°	69°	67°	71°	82°	88°	89°	87°	74°	80°	61°	61°	89°	75°
Grant-Mecca	65°	65°	65°	72°	69°	74°	79°	80°	80°	80°	77°	73°	65°	80°	73°
Grant 0.5	65°	65°	64°	71°	69°	76°	81°	81°	82°	79°	75°	71°	64°	82°	73°
Hayes St.	67°	68°	67°	72°	69°	73°	78°	81°	83°	79°	77°	71°	67°	83°	74°
Hayes 0.5	64°	64°	63°	69°	69°	73°	77°	78°	80°	80°	78°	70°	63°	80°	72°
Garfield	69°	72°	65°	73°	72°	77°	83°	84°	83°	83°	80°	74°	65°	84°	76°
Garfield 0.5	72°	70°	70°	72°	72°	77°	81°	83°	81°	83°	80°	72°	70°	83°	76°
Arthur St.	70°	70°	70°	70°	71°	75°	79°	80°	81°	80°	79°	75°	70°	81°	75°
Arthur 0.5	68°	69°	68°	70°	71°	73°	80°	80°	81°	80°	78°	73°	68°	81°	74°
Caleb	70°	69°	71°	70°	70°	73°	76°	78°	80°	80°	78°	72°	69°	80°	74°
AVERAGE	76.1°	69.6°	69.8°	71.8°	73.0°	79.1°	82.3°	84.6°	83.2°	80.4°	78.1°	71.4°	66.1°	86.4°	75.9°

From CVCWD Form No. H-326, "Discharge Measurement Notes".

The temperature of the water in the drains is measured monthly when and where samples are obtained for chemical analysis. In this regard, the temperature of ground water tends to remain much more constant through the year than does surface water. There are also some naturally heated ground waters found in Coachella Valley. These are not found, however, at the depths of tile drainage. The temperature of the deeper ground waters remain essentially constant throughout the year, until it is discharged by pumps at the ground surface. Temperature of the shallow waters intercepted by tile drains does vary slightly from summer to winter, but only by a very few degrees. Thus, water in the ditches must be expected to be cooled in summer, and heated in winter by the inflowing tile drainage waters. Thus, the water in the ditches is far more uniform through the year than would be true if there was no tile drainage inflow. This greatly improves the ditches as a habitat for the fish. (See Exhibits USGS Water Quality Analyses 10/31/77 & 2/27/78 for 4 drains E1 to E8.) (Also see Table III).

D. Chemical Characteristics of Water in Open Drains

The District obtains monthly samples of water from some 21 stations on the system of open drains. Analyses are made for electrical conductivity (EC), total dissolved solids (tds), boron (B), calcium (ca), magneisum (Mg), sodium (Na), potassium (K), carbonate (CO_3), bicarbonate (HCO_3), sulfate (SO_4), chloride (Cl), nitrate (NO_3), fluoride (F), and temperature (in degrees F). Computations are made of these for sodium-absorption-ratio (SAR), percent sodium (% Na), tds/EC, sums of cations, and sums of anions. SAR and % Na are measures of the effects of the ions on soil permeability. The EC/tds ration establishes a quick way to estimate tds from the rapid determination of EC.

As regards the EC of drainage water relative to the EC of the irrigation water, and omitting the measurements at the mouth of the Coachella Valley Stormwater Channel because of dilution with lower salt content urban liquid wastes, the drainage water is found to be concentrated by a factor of only about two. Normally, with the more uniform and finer textured soils of other areas, a factor of about 4 could be anticipated. Even though the soils are so spatially variable, one would expect to find a concentration factor somewhat greater than two. Bower (25) did find for the Valley that, where a theoretical leaching requirement of 20% was indicated, the actual leaching requirement was 30%.

The concentration of boron in the drainage water is surprisingly low since many of the saline soils of the Valley were high in boron. There is also a surprisingly low concentration factor for boron. One would expect it to at least double, which it does not. Boron, while an essential plant nutrient in low concentrations up to about 0.1 mg/l, problems can be caused by concentrations of something more than 0.7 mg/l, in irrigation water. This is because, with plants growing on land, the boron readily moves up through the roots to the leaves, where it can go no farther. Water movement beyond the leaves is in the vapor phase because of transpiration. Thus, it accumulates in the leaves until concentrations there are several hundred fold more than in the water. With aquatic plant life, there is no transpiration; so concentration does not occur. Thus, boron is not harmful to aquatic life.

There is no undue increase in SAR or % Na in the drain water, and that means that there is little precipitation of calcium carbonate, magnesium carbonate, or calcium sulfate in the soil. Because there is fluoride native to the area, there is a moderate increase in fluoride, but not a harmful increase.

There have been instances of high nitrate in Coachella Valley ground waters. In one instance investigated above Point Happy (2) the grower was advised to stop applying any nitrogen fertilizer. In another instance down near the Oasis area, an entire citrus orchard was killed. This was not investigated, but was reputed to be because of use of irrigation water from a well extremely high in nitrate. The relatively high small pockets of nitrate ground waters were only observed before the advent of Colorado River water, and are of questionable importance today. Today, there are moderate amounts of nitrate and phosphate (27) in the drainage waters, but no adverse effects have been observed. There appears to be simply a good food web in the waters.

About the only thing harmful that can be said about the chemical characteristics is that it is too salty for agricultural or urban reuse.

E. Bacteriological Characteristics of Open Drain Waters

Mr. P. F. Merrin, Jr. of the Bureau of Sanitary Engineering, California State Department of Health, has made a study of the bacteriological safety for water contact sports of the District's open drains, of the waters coming out of the tile drainage pipe collection system, and around the northwestern shores of the Salton Sea. In 1969 he made a tentative draft of his report available, in which he tentatively concluded:

> 1. There is no indication that self-purification or dilution has eliminated the hazard associated with the undisinfected wastes in the waters of the Coachella Valley Stormwater Channel. The high coliform and fecal coliform MPN values indicate the water is bacteriologically unsafe for water-contact sports activities.
>
> 2. Most of the open agricultural drains that were sampled cannot be considered bacteriologically suitable for water contact sports.
>
> 3. Half of the closed agricultural drains that were sampled contained water that can be considered bacteriologically suitable for water-contact sports.

4. It does not appear necessary to post or otherwise restrict the already limited recreational use being made of the agricultural drains not receiving sewage effluent.

5. It appears that a ratio of fecal coliform to coliform bacteria within a meaningful range cannot be established in the Coachella Valley for either the agricultural drains receiving sewage effluent or the agricultural drains not receiving sewage effluent. The magnitude of the MPN values apparently has little bearing on the ratio of fecal coliform bacteria to coliform bacteria.

6. The area of the Salton Sea in the vicinity of the mouth of the Coachella Valley Stormwater Channel is considered unsuitable for water-contact sports on the basis of bacteriological analysis and the known discharge of undisinfected sewage to the channel.

7. The fecal coliform test more closely matches the known environmental conditions at the Salton Sea than does the coliform test.

8. The near-shore waters of the Salton Sea directly affected by agricultural drains not receiving sewage effluent can be considered bacteriologically suitable for water-contact sports.

9. The near-shore waters of the Salton Sea away from the direct influence of agricultural drains can be considered bacteriologically suitable for water-contact sports.

(Mr. Merrin's draft report was only recently provided, and it was not realized that the work had been done in 1969. The California Department of Public Health and the Regional Water Quality Control Board now require that sewage effluent discharge from the wastewater treatment facility site shall be chlorinated to reduce the coliform count down to between 2 and 23 coliform per 100 mil, this requirement varies depending upon the degree of public contact with the effluent. The limitations per 100 mil, which is approximately 5 fecal coliform per 100 mil (40 times more strict than the Federal limits for sewage effluent discharge to surface waters.) These far more strict requirements, whether justified or not, raise a question as to Mr. Merrin's Statement No. 6 above.)

The chlorination of liquid wastes going into channels such as the Coachella Valley Stormwater Channel can have a mixed effect if there is any chloride residual. Such residual would have an adverse effect upon the aquatic biota, damaging the food web, and thus the fishery (28). Also, many of California's "pristine pure" mountain streams have high fecal coliform counts, apparently imparted by wildlife that wade in the streams while drinking and refresing. Thus, there is question as to the effect that man has had upon fecal coliform.

Apparently, the same standards as to fecal coliform are required near the outlets of the open drains of the District even though the soft, fine-textured soils are not suitable for water contact sports. There are sandy beaches to the south that are far more preferable.

F. Pesticide Residues in Open Drain Waters

As previously mentioned in the text, pesticide residues in downstream waters primarily originate from surface tail waters, and the residues in tile drains would be expected to be quite low (16 - this work was done in the San Joaquin Valley rather than in Coachella Valley, but this fact in no way impairs the validity of the results.) Pesticide residue analyses were made of five grab water samples in 1976-77 from two sites in the Coachella Valley open drains, analyses made by the U. S. Geological Survey Laboratory in Arvada, Colorado. The two sites of concern are on the Avenue 64 Evacuation Channel, and on the Coachella Valley Stormwater Channel near its mouth. The pesticide residues detected are generally quite low, and are shown in Table III.

If traces of pesticide residue have gone through unsaturated soil, those detected are very low, but continue long enough so that grab samples collected at two month intervals might have some merit. However, if the traces detected came from surface tail waters, surreptitiously discharged into the ditches, they are of most questionable value. Under the circumstances, the District is certainly not justified in going to the expense of patrolling the ditches. (If the waters were the property of the State, as claimed, patrolling would be the responsibility of the State.) More recently, it has been reported that the flesh of one fish has been analysed for pesticide residue. While analysis of fish flesh is a far better technique, any response must await a reasonable collection of samples.

Any impairment in quality by pesticide residues in waste water depend upon what reasonable use is to be made of that water, and upon the concentration of those residues. When the level of Salton Sea drops appreciably, and there no longer are fish, the Sea will be simply the sink that it was naturally, and any pesticide residues represent no problem.

G. Biological Control

The present fish that the District is concerned with in biological control are the Tilapia zillii, which the District purchases and maintains to avoid costs inherent in dredging and pesticide spraying. There is considerable continuing expense with these fish. If biological control and research are inhibited the farmers may come to object to the trampling of their crops, to the pollution left by fishermen, and to even paying the District to maintain the fish controls. Then there will be no fish, and full resumption of dredging and herbicide control will be required.

Relatively few biological controls of pests have been found which man has been able to use effectively, but University of California, Riverside, scientists, working under a program funded by Coachella Valley County Water District, by Imperial Irrigation District, and by Palo Verde Irrigation District, have found an effective biological herbicide in the form of an East African fish, Tilapia zillii (31). Present California Fish and Games Commission policy limits the stocking of Tilapia zillii to the Imperial and Coachella Valley. (See Section 671.1, Title 14, California Adm. Code permiting Tilapia zillii planting). Other possible vegetation eating fish are the Tilapia mossambica and the white amur (Ctenopharyngoden idella). The former is not as tolerant to temperature as the Tilapia zillii, and the latter is banned in California despite experiences in other states and the Panama Canal (53).

Therefore, attention is now concentrated on Tilapia zillii. To date, these fish have been highly successful. At first, they ate only the plant life that they preferred (31). However, as they multiplied, and as the prefered food became scarce, they ate all the vegetation that they could manage. They even ate the small new shoots around the periphery of clumps of cat tails, preventing those clumps from expanding all over the ditch. They eat any filamentous algae, and "mow" the grasses and forbs growing as far as they can reach above the water surface. It is noted that, where there are good populations of Tilapia zillii, there are also good populations of other fish, although there has been no quantitative research in this area. The clumps of vegetation such as cat tails are controlled, but not eliminated. Similarly, populations of pupfish might be controlled, but not eliminated.

Because of the success of Tilapia zillii, the District's maintenance program has been greatly reduced. Generally, it is limited to dredging of storm channels after floods, and to situations where there have been heavy infestations of gophers. In both cases, the clogging must be removed by dredging, to keep the ditches open for the purpose for which constructed, and to maintain an environment suitable for the fish. Except for salt cedar and arrowweed, the spray program has essentially ceased, as well as most of the dredging. It must be remembered that selective spot spraying is essential if the ditches are to continue the function for which constructed (31).

The operating personnel charged with maintaining the open drains believe that the fish may be becoming more temperature tolerant because they have survived the last two winters without much restocking. Normally, the greater part of the flow of the open ditches is tile drainage effluent. This is ground water that is colder in summer, and warmer in winter. Once it is surface flow, it starts to approach the ambient air temperature. Tilapia zillii are completely killed with two weeks exposure in water 12° to 13°C. No one really knows if the fish will survive a really cold winter - the last two have been relatively mild.

Another observation of the operating personnel is that the fish do survive in the Salton Sea, at least long enough to swim from one drainage ditch to another. This conclusion was reached because they have been observed in open drains where they had not been planted; so apparently the salinity tolerance may be greater than originally believed.

Finally, attention must be directed to the fact that the fish have been purchased, planted, and maintained by the District for its own purposes and in ditches belonging to the District. Therefore, the District considers that anyone catching the fish is poaching on its property.

The alternative Best Management Practice of aquatic weed control could well be controlled introduction of the white amur. A species found only in the Siberial Amur River (53, 54, 55).

The procedure proposed is to expand the present Tilapia zillii program described above to include the white amur at least in the Coachella Valley. The program developed by the three irrigation entities, is supervised by the University and funded by the irrigation organizations and the University.

There is an institutional problem to introducing the white amur, i.e. the Department of Fish & Game questioned any research project for the importation and planting of the white amur at the present time even though the Coachella Valley is a closed basin and would be ideal for a controlled research project. The State Department of Food and Agriculture has recognized the beneficial uses of the white amur in the control of hydrilla (noxious weed) and has proposed the use of this fish as one of several alternatives in the control of hydrilla. The white amur consumes hydrilla very readily. (53, 54). Also the State legislature has adopted AB 2110, now a part of the statutes permitting the use of fish as a biological control of hydrilla. Some of the advantages of the use of white amur compared to Tilapia zillii are as follows:

*	White Amur	Tilapia Zillii
Concentration of fish plant	10-12 per acre	1,000 to 1,500
Temperature tolerance	32°F to 100°F	55°F to 103°F
Length of life	8 to 12 years	3 to 4 years
Mature fish weight	40 to 60 lbs.	3 to 4 lbs.
Weeds consumed	Wide variety	3 to 4 varieties
Amount Consumed	3 to 6 body wt/day	1 body wt/day

* Table compiled from American Fisheries Society reports (53) et seq.

These two species of fish will survive together and by planting both species one may complement the other. The concerns expressed by the Department of Fish and Game in a paper prepared by Ronald J. Relzon in 1971 (Inland Fisheries Adm. Report No. (71-14) should have been satisfied by more recent studies, experiments and fish plants by the Arkansas Dept. of Fish and Game also by the Florida and Texas Departments of Fish and Game. (53 to 56).

The California Department of Fish and Game is aware of these recent and tested findings. The Coachella Canal lends itself very well to be used as a large aquarium. A 32 foot drop near station 300 + .00 will prevent the migration of the fish to the Colorado River and the lowest drainage on each point of the Coachella Canal and Distribution system is the Salton Sea. The white amur will not survive in the salt concentration of the Salton Sea, thus presenting an ideal controlled, research project location.

If further safeguards are needed to protect the Department of Fish & Game a section of the Coachella Canal may be quarantined to prevent any human involvement of the white amur.

There is no air, soil or water pollution by the white amur in controlling aquatic weeds. The White amur will not cause of silt disturbance in the canal when compared to the mechanical removal. It might be said it is environmentally acceptable.

If sufficient numbers of white amur are stocked in the Coachella Canal hundreds of KWH of electricity, gallons of fossil fuel and many dollars will be conserved when compared to the alternative of a mechanical removal of aquatic weeds.

Aquatic weeds removed by the present mechanical method acquired fossil fuels for operation of tractors, KWH of electrical power to remove the aquatic weeds after they are torn free from the Canal bottom and sides, and manpower to operate the necessary equipment.

H. The Need for Urban Development to Avoid Agriculture

The need to sustain a healthy agriculture has been discussed. Also, urban man yearns for "greenbelts" to enhance his environment. He is finally learning that he cannot put all the land aside for greenbelts that he desires when that entails tremendous costs for development and upkeep. Therefore, he is turning his eye to agriculture to put the concepts of greenbelts on a productive, sustaining, and "free" basis (29). Nothing has meant more to the enchantment of Coachella Valley than its date gardens. The grapefruit, other citrus, and grapes follow in short order. Also, the forage, truck, and field crops are important. Urban man values these greenbelt amenities, and it hardly makes sense for him to destroy them.

Another factor should be mentioned. Tile drainage makes land arable rather than it being salt encrusted wasteland. Tile drainage systems require careful maintenance and supervision, and land without such systems is not readily convertable to urban lands even if, somewhat maintenance can be continued. There have been serious problems in Imperial Valley when urban development encroached upon tile drained land. Thus, the trend towards urbanization should not be allowed to encompass present or potential tile drained agricultural land. This would be severely adverse to the quality of the urban land, as well as detrimental to agriculture.

IV. AGRICULTURAL SURFACE RUNOFF

A. History

Essentially all of the soil of the floor of Coachella Valley is recent alluvium, extremely and irregularly stratified and wind modified. The soil really describes the history. Flood runoff, as surface water, has occurred everywhere, time and time again, ancient Lake Cahuilla has existed periodically throughout the past, bringing a touch of Colorado River sediments to much of the Valley, and dominantly where the Woodrow soil series is found. Man has modified this, primarily in the last 50 years. He has built levees to confine all of the flood flows to defined channels. Some of these efforts have failed, and many more will fail in the future. Ultimately, in hundreds to thousands of years, all can be expected to fail because of the tremendous loads of sediments that will be deposited on the land. However, man has tamed the floods, and can utilize the land, usually with rather minor losses, for the usual brief number of years of 50 to 100 as the span for which he plans his agriculture and his urban developments.

The Whitewater River, the mouth once at Windy Point northwest of Palm Springs, now channelized by works constructed by the District along historic alignments, runs down the valley to Point Happy. From Point Happy to the Salton Sea it becomes the Coachella Valley Stormwater Channel on a new alignment entirely District-made which by-passes Indio and Coachella to effectively protect against innundations of those communities. The Storm Channel is built on rights of way purchased by the District when the Coachella Valley Stormwater District began operations in 1915. Prior to that time and until the new channel was constructed the floodwaters disgorged at Point Happy into various meandering channels eventually reaching the Salton Sea.

On the northeast side of the Valley, and primarily to protect the Coachella Canal, a series of essentially level dikes have been constructed. The soil used for the dikes was taken from borrow pits on the upstream side of the dikes. This forms long flat depressions that will become ponds during flood flows from the Little San Bernardino Mountains. These will protect the Canal, and the developments below. They will also do much to recharge ground waters. When the more rare floods exceed the capacity of the detention basins or ponds, three "detention channels" have been constructed to channel those flows down to Salton Sea. The largest, Detention Channel No. 1, spills directly into Salton Sea. Nos. 2 and 3 on up the Valley, spill into the Coachella Valley Stormwater Channel, and thence to Salton Sea. To catch floods from the Santa Rosa Mountains on the southwestern side of the Valley, there are levees above, and then six stormwater channels that empty into Salton Sea. There is also the Avenue 64 Evacuation Channel, part pipeline, part ditch, and part both, that can intercept flood flows. All other open drains are designed to provide outlets for pipe collector lines exclusively. These are all shown on Map C.

The above works are all necessary to keep the roads and highways open, and to protect the land, and the improvements on that land, and to protect the Coachella Canal. The dikes above the Coachella Canal were designed to provide protection for a standard project flood.

A previously cited reference (1) gives information on the floods that have plagued Coachella Valley since the time of first settlement. Floods, obviously, have dominated surface runoff, and the agricultural surface runoff is coordinated with that. Agricultural surface runoff during periods of heavy rainfall has been similarly infrequent, and no deliberate provision has ever been made for it, except as provision has been made to handle tail water. The provisions are the same. As previously mentioned, some tail water runoff apparently occurs. However, where this is true, locations are widely scattered over the Valley. The flows, because of the nature of the soils, would be somewhat irregular, and of short duration. This makes such flows almost impossible to monitor and not cost-effective. It is questioned whether or not they are of significant importance. Any pesticide residues in the downstream environment would be primarily from this source, but the evidence does not now show these to be of significant importance.

B. Existing System

The existing system has changed little in the last 12 years, and is shown on Map C. It has already been described.

C. Pesticides and Nutrients

Nutrients in agricultural surface runoff, from whatever source, are sufficient to initiate a good aquatic food web, but are in no way excessive. Any importance of pesticides is certainly yet to be established, but the fine existant fishery indicates that they are not excessive.

V. ALTERNATIVE MANAGEMENT PRACTICES

The issue here is, what effect would alternative management practices have on the environment of certain open ditches, constructed by the District to provide drainage for its farmers, and/or to provide flood relief for those farmers, and for the many travelers and truckers utilizing the State Highways on both sides of the Salton Sea. The farmers, incidently, pay in full for the ditches and the continuing costs of maintenance. As a means of reducing the ever increasing costs of maintenance, the District imported a vegetation-eating fish, *Tilapia zillii*, to keep the drains open, and thus reduce dredging and spraying. These fish have flourished, and for least two mild winters, have survived the cold weather. This minimizes the need for restocking.

The fine fishery exists because the farmers needed to have an aerated rootzone for their crops, and needed to establish salt balance. The ditches are an essential part of that subsurface drainage system. Without a healthy agriculture, there would be no one to maintain the good environment for the fish. Considering the amenities of a healthy agriculture, there would not be the amenities that bring people to the region, and few fishermen.

The fishery also exists because of the present high level of the Salton Sea. The drains, when many were constructed, did not contain enough quiet water to support a fishery. If the level should rise much higher, it would drown out agriculture. If the level begins to lower, the ditches will start to drain. The District will lose the fishery, and be faced with higher maintenance costs.

It might be said that the level of Salton Sea represents a management alternative. This fails to recognize the serious over-commitment of waters of the Colorado River as illustrated in Table IV. Not only will California have to drop its present use of 5.36 million acre feet per year to 4.4 million. The water going into the Salton Sea today is tile drainage effluent, tail water, regulatory waste, and storm runoff. Considering that tail water and regulatory waste can be significantly reduced, it would appear to be inevitable that there will be much less flow into the Salton Sea in the future. The Central Arizona Project is under construction, and the Upper Basin states are working to utilize their full entitlement. There remains an alternative of importing

TABLE IV

ENTITLEMENTS TO COLORADO RIVER WATER

	Million Acre Feet
Upper Basin States (Wyoming, Utah, Colorado, New Mexico) . . .	7.5
Lower Basin States (Arizona, California,* Nevada)	7.5
Mexico (by Treaty)	1.5
Evaporation and use by phreathophytes	1.0
Total entitlement per year	18.5
Actual average annual flow	13.8

*California now uses 5.36 million acre feet per year. After CAP becomes operational, it will be limited to 4.4 million acre feet per year. Note that far more water is allocated than actually exists. There must be further cuts.

water from the Columbia River and Canada. Considering that all of the Colorado River Basin states have disclaimed any desire to import such northern water, such a possibility is presumed to be beyond the scope of this report.

The above discussion is intended to show that possible and probable alternatives are severely restricted. It must be assumed that the level of Salton Sea will soon begin to recede, and that salinity will increase to the point where fish cannot survive (Just what that level of salinity might be, the writer does not know, but he has had intimate contact with Salton Sea when it did not support any fish, and he is aware of other sinks where fish no longer survive.) Further, the lowering of the Salton Sea will drain the open ditches of the District. Without maintenance, there will then be no fish life in those drains, as there were none some 30 years ago when the District was busy with the original dredging. Fish life came subsequently with the continued rise in the Salton Sea.

The above discussion shows that the alternatives are severely restricted. It might be mentioned that the District can and will install drop structures in the ditches to preserve as many of the _Tilapia zillii_ as practical to keep the ditches clean. It cannot be expected to deliberately strive to maintain an entirely artificial environment for "diverse" fish life. Nor can it be expected to look kindly towards itinerant trespassing fishermen who take the fish that the District pays for and maintains, who trample the crops of the farmers, and who leave behind all manner of bottles and cans and other trash to pollute the environment. Rather than tolerate that, it would forget trying to maintain the fish, and resort to simply dredging and herbicides as more practical and cost-effective.

A. Alternatives in Surface Runoff as Affecting Pesticides & Fertilizers

Agricultural surface runoff does affect the amount of pesticides and nutrients going into the dowstream waters, as previously discussed. However, while there are sufficient nutrients to initiate a good food web for fish, there is no evidence of any excess of nutrients. The fish readily devour all algal type of plant life, the scum types and the types below the surface. They also utilize most of the types of plants that have roots. Fewer nutrients will simply mean less food for the fish, but it is difficult to determine whether or not this will have an appreciable effect on the environment. With the rising prices of fertilizers, farmers can be expected to use less, and to use it more efficiently. This can only mean less getting into the downstream aquatic environment.

As to pesticide residues, modest monitoring efforts to date have been on getting a few grab samples of water at two months intervals. Since, if there are any high concentrations of the residues, they would be highly transient and grab samples would be of questionable value. It would be preferable to sample mature fish that have been in the water for a considerable period of time. It is understood that the flesh of _one_ fish specie and physical condition unknown, has been analysed. Any firming up of alternatives must await statistically viable information. There is, further, the rather strange concept that the District buys, rears, and manages the fish for the benefit of the itinerant fishermen. Actually, the District does this to lessen its dredging and herbicide application costs, and has no concern whether or not the fish are edible. One alternative, then, is for the Department of Fish and Game to post the ditches, calling attention to the fact that the fish are not edible (if it is shown that the flesh of the fish is high in pesticide residues). In the future, when it is almost certain that the level of Salton Sea will be much lower, an alternative for the District is to simply forget about keeping fish in the ditches. If there are no fish, there is no conflict with regulatory agencies, and no fish would be the natural environment.

It is possible that there might, from time to time, be surface runoff from heavy precipitation. This is so infrequent that farmers do not make permanent provision for it. Instead, to avoid losing significant amounts of soil, they may well make emergency and temporary provisions. Weather forecasting is so inexact that that there is no viable alternative, if there should be runoff-producing precipitation.

B. Impacts Due to Mechanical Dredging of Open Drains

There is concern that dredging is harmful to fish life because: (a) It increases turbidity. (b) It can release any pesticide residue bound in the sediments. (c) It can destroy the benthos fish food source. (d) It destroys cover over the water. (e) It directly removes fish from the water. (f) It destroys wildlife habitat. (g) It increases water velocities and reduces backwaters. (h) It allows downstream sediment deposition. (i) It reduces oxygen levels because of increased B.O.D. suspension. These effects are temporary. The thing to remember is that dredging, and only dredging, created an environment suitable for fish, and only dredging can maintain such an environment. The ditches were created to provide outlets for tile drainage systems, and this requires that original levels be maintained. Dredging is expensive, and no one wants to dredge. But, if agriculture is to be maintained, there must be dredging, and the District does no more than necessary. In short, no dredging, no agriculture, and no fish.

Floods invariably deposit sediments in open drains, usually coming from lands far above the Valley. Deposition is accelerated if the ditches become clogged with vegetation. With almost any flow, the water tends to meander, undercutting the banks, first on one side and then on the other. Vegetation minimizes this. This includes the roots and the vegetation on the banks. The Tilapia in the ditches have essentially stopped ditch bank erosion, and the District, therefore, wants to keep a good population of these fish as long as possible for biological control.

Next, it should be emphasized that the carrying of sediments is a natural phenomenon of flood flows. Many rivers have a sediment load most of the time, and the fish do survive. The few open ditches in Coachella Valley were dug in soil material that originated as sediments carried in flood waters. The natural floods are broad flat fans of water and sediments, and the locations of these fans are constantly changing, except in a few spots in a few locations where slopes are excessively steep. Without the artificial ditches being dug, they would become that way again. This would mean no drainage, and no fish habitat. Dredging may be temporarity adverse to fish life, but there would be no fish without it. District dredging is minimized now.

The District dredges Coachella Valley Stormwater Channel, where there is no alternative. Dredging may be temporarily somewhat adverse to the herbivores, but most survive, and there after they do have a healthier environment.

It should be mentioned that there are a few drains feeding into the Salton Sea where there is sufficient grade to the land so that there is not the usual threat that, without maintenance, the ditches will simply fill up. Scour could be expected to start at the downstream end, and erode upstream. With these, the District has installed periodic low drop structures covered with plastic sheeting, to prevent erosion. No Tilapia have been observed in these, but there are many fingerlings, unidentified, that are probably juveniles from Salton Sea.

C. Use of Herbicides and Aquatic Herbivores

Since it is in the nature of open drains to become inoperative for the purpose for which they were dug, there has always been a spray program with herbicides. Since aquatic weeds also increase the deposition of sediments, particularly in the stormwater channels that also serve as drains, application of herbicides also lessens the need for dredging.

As to the spray program for the open ditches where Tilapia zillii are not present, the material used at present is Silvex. This takes care of all problem vegetation except salt cedar. For all drains, there is a once-per-winter spray program maintained by the District using 2,4D, which controls salt cedar and all other nuisance vegetation. The same 2,4D program is also utilized on the unlined portion of the Coachella Canal. The vegetation controlled there is salt cedar, arroweeds, cat tails, and sedge.

There is no spray program for the lined portion of the Coachella Canal, nor for any of the distribution system. There are, however, great quantities of vegetative debris in the Colorado River water. This is removed before the water goes into the pipe distribution system by a series of automated screens.

Wherever the Tilapia zillii fish have been established in the open drains, the spray program and the dredging program have just about completely stopped. Tilapia zillii have eating preferences, so are selective. But, as their numbers increase, and food tends to become somewhat inadequate, they start to eat everything that they can manage. In particular, they eat the new sprouts of the coarse vegetation such as cat tails. This controls the size of clumps, virtually eliminating the need for spraying, except the salt cedar. They readily eat the algae, including the filamentous type. They also effectively "mow" the grasses and forbs as far up the banks as they can reach. Thus, the water is relatively sparkling and clean, presuming no other sources of sediments.

D. Agricultural Surface Runoff

Surface runoff is of two types: (a) Storm runoff from flooded fields does occur at infrequent intervals. It is infrequent because of the dominantly permeable nature of the soils, and because the rainfall in the Valley is usually so low. However, when intensive rains do occur, the farmers generally do not want to lose soil from their fields that have been rather precisely graded. This does not present a problem for most farms because the water simply flows into the shallow ditches at the side of the roads. When the low side of a farm happens to abut an open ditch, or a stormwater channel, the farmer usually tries to put in a temporary drop structure to prevent soil loss. (b) The other type of agricultural surface runoff is tail water, and the evidence appears to suggest that this does not occur with any great frequency in Coachella Valley, or involves any appreciable amount of water or sediment. However, this is an area where good facts are lacking. Optimum decomposition of pesticide residues would be expected in tile drainage effluent; so concentrations would be low and the flow in the water more sustained. Because phosphates tend to be fixed in the surface soil, phosphate content of the effluent would be low. Nitrates would be expected to discharge freely in the effluent. These would drastically change when there is water in the ditches of high turbidity - from storm runoff, from tail water discharges, from gopher activity on the banks of ditches, and from undercutting of ditch banks.

There is natural sediment production from floods. In its flood control function, the District does ameliorate this so far as practical, and does reduce the amount of sediments accompanying floods. However, as whenever man attempts to modify all rare natural occurances, there are strict limitations on what he can do. This fact must be recognized, and not expect man to drastically change the world.

VI. IDENTIFICATION OF BEST MANAGEMENT PRACTICES, AND AGENCIES RESPONSIBLE FOR IMPLEMENTATION

A. Best Management Practices

On the basis of previous discussion, it is now necessary to develop the Best Management Practices (BMP). The open ditches of concern were developed by agriculture to keep the agriculture of the Valley viable. Without a viable agriculture, the area would also cease to be a prime recreational area. It so happens that the rising level of the Salton Sea, in conjunction with works required by and paid for by agriculture, does today provide a good, but artificial, environment for fish that never existed under nature. The fish, purchased by, and maintained by the District are the *Tilapia zillii.* These eat the available tops of vegetation while leaving the roots to help keep the soil stabilized. So far as the District is concerned, these fish are their fish, and not the property of itinerant trespassing fishermen who trample farmers crops, and leave all manner of empty bottles and cans, and other trash, in their wake. The BMP then, must hold that the interests of the farmers and the District are above and superior to the interests of the fishermen.

On the above basis, the BMP are hereby summarized as to salt balance, the nutrients in the waste waters, the pesticide residues in the waste waters, and the sediments carried by the waste waters:

1. Salt Balance. Unfortunately, the District has not, during the 1970's given sufficient attention to the drainage system to clearly maintain salt balance. There is near-balance, and the situation is not yet really out of hand. However, some attention should be given to this to see that salt balance is strenthened. BMP must provide salt balance.

2. Nutrients. There are nutrients in the effluent from tile drainage. Basically, this means that the farmers are losing some of the fertilizers that they buy and apply, possibly because of the timing of application and irrigation. The cost of fertilizers has been increasing appreciably over and above the rate of inflation. Also, the cost of water has been rising steadily, if only moderately. These two factors together should indicate that there probably will be decreases

in the concentrations of nutrients (really only nitrates) in the waste waters. At least, with the Tilapia zillii in the drain waters, there is no evidence now of any excessive amounts of nutrients in those waste waters, and therefore, no problem. The BMP, therefore, requires no change from present practices. Nitrates should continue to be monitored to see if the situation might unexpectedly change in the future.

3. Pesticide Residues. There is not yet firm evidence one way or the other concerning the levels of pesticide residues in the waste waters, or in the flesh of fish in the open drains. An ultimate BMP must await such data. If the levels in Tilapia zillii are found to be high, a BMP might be for Fish and Game to post the ditches to warn the trespassing fishermen, if the fish are otherwise healthy for the purpose purchased and maintained, that the fish are not edible. If and when there are no longer fish in the open drains, or in Salton Sea, the concentration of pesticide residues will cease to be of concern to the BMP.

4. Sediments. In the event of precipitation that causes runoff, the waters of the storm drains can be expected to have high turbidity. Also, any surface runoff of storm waters from farm land can be expected to be turbid, whether or not the farmers are able to improvise some kind of drop structures. Some turbidity can develop from the erosion of ditch banks, and can be quite severe where gophers have been working on the ditch banks. If there is ever any turbidity of effluent from tile drainage systems, it is obvious that some farmer has trouble which he must correct, but this is rare. Any other turbidity of ditch water, not here-to-fore mentioned, must be associated with the surreptitious dumping of tail water. Thus, when and if such turbidity is found to be a problem, following up of turbidity can be the mechanism for policing tail water dumping.

As regards flood runoff, the District has already taken all reasonable steps to minimize turbidity. Major floods always do create havoc, and this is particularly true under the desert and coarse textured soils in the environment of Coachella Valley.

B. Further Considerations

The Salton Sea is a natural, and a federally designated, repository for the salts required to achieve salt balance in agriculture. There have been, in past eons, many transitory periods when the Salton Sea was a habitat for fish. There have been even greater periods when the Sea was either too saline for fish, or had become almost dry. There will be many more such periods in the future, both with and without fish. Although man may have the capability to modify it somewhat in the future, he cannot exercise complete control over the level of the Salton Sea, or over its salinity. Therefore, it is not realistic to maintain the illusion that BMP relates to any water level in the Sea, nor to any degree of salinity.

Man did, once in the past, shift the flow of the Colorado River back to the Gulf when it had shifted in flood to Salton Sink. He may be able to continue to do so in the future for maybe 100 or 200 years. However, because of the mountains of sediments involved, he cannot hope to do so permanently. About all that can be said is that the probabilities of another Lake Cahuilla in the next 100 or 200 years are low.

Speaking more to the immediate future, the District, and the farmers within its Colorado River water service area, can affect the small amount of surface tail water that goes into the open drains. The District's pipe distribution system is fully metered. Therefore, the District has precise information on the amount of water each farmer uses. This encourages efficient irrigation in comparison with other districts. Sprinkler irrigation might be considered the BMP for some crops in some environments, but certainly it cannot be considered the BMP for all crops in all environments of the Valley. Drip irrigation, with portable sprinkler systems for periodic leaching, might also be considered by some to be a BMP. However, practical cost-effectiveness will dictate acceptance. Also, no important environmental impact is involved in the application of present irrigation.

C. Responsible Agency

The District is now the responsible agency, and, all things considered, it has performed a remarkably capable job. There is no other agency that could even approach the capability of the District. These facts make it imperative that the District continue its responsibilities.

VII. ENVIRONMENTAL IMPACT ASSESSMENT

A. Significant Adverse Environmental Effects Caused by Alternative Management Practices

If Coachella Valley farmers had been willing to accept the plans first proposed by the Bureau of Reclamation for the Coachella Canal, and for the distribution system, there is no doubt that there would have been a most serious and adverse environmental impact upon Coachella Valley. There would have had to be many additional open drains, and, in particular, intercepting drains around the periphery of the Valley trough. There would have had to be many more miles of open drains with their high maintenance costs and loss of tillable land. Tail water would probably have been of far more common, causing substantial increase in the transfer of pesticide residues into the ditches, and thence to Salton Sea. As it is, the remaining management alternative would have a most moderate environmental impact.

It might be well to review the environmental impacts of more drastic measures not now contemplated.

1. Stop all herbicide spraying to keep ditches open

Where *Tilapia zillii* are now established, spraying with herbicides is almost stopped now, except for winter spot spraying of salt cedar, as required. There are a few ditches where the fish have not yet been established. With these, agricultural deterioration would be fast, with severe economic and societal effects. The ditches would cease to provide an environment for the future planting of the fish. The depressed agricultural condition would adversely affect the Valley as a winter resort for urban people, and as a place to which to retire.

With the above in mind, there appear to be only two alternatives designed to enhance the environment, to wit:

(a) Take measures to stop any tail water discharge unto the open ditches, when, and if, any high concentrations of pesticide residues are found in the flesh of the fish. The environmental impacts:

-- This will increase irrigation costs to the farmer. Otherwise, he would not go the expense of providing for the wasting of water that he has purchased.

-- The action would substantially increase costs to the District.

-- The trespassing itinerant fishermen will be assured that the fish that they catch are edible, and there is less chance of contamination.

-- There will be an insignificant decrease in the pesticide residues in Salton Sea. However, by that time, the Sea will probably be too saline for fish.

(b) That the proper regulatory agencies post and patrol the ditches where the adversely affected fish are found to see that there is no fishing. The environmental impacts:

-- This will deny the trespassing fishermen access to the fish that they have been catching.

-- There will be an insignificant increase in the pesticide residues going to Salton Sea.

VIII. CONCLUSIONS

A. Salinity

This District supports the salinity control program as adopted by the State and Federal Governments. No special District work is needed to meet these controls.

Since all seven basin states have adopted the Colorado River Basin Salinity Control forum's water quality standards for the Colorado River, and the state-adopted standards have been approved by the Environmental Protection Agency, implementation procedures are provided which will accrue to the benefit of agricultural water users in the Coachella Valley.

Problems of salinity are not problems of pollution, regardless of what any man-made "laws" say. Salinity is a concentration process caused by natural phenomenon, by evapotranspiration and evaporation, where water is removed, but all natural salts stay in the remaining water. Irrigated agriculture does increase evapotranspiration and evaporation most significantly. The only real and long-term solution to salinity problems is: (a) gradually move upstream for the source of supply, and (b) allow the lower reaches of rivers to become more and more saline. (an interim solution would be to build a combination nuclear power-distillation plant at a location where the brine could be discharged to the Gulf. A combination plant provides over a two-fold savings in distillation costs).

The potential shortage of water for irrigation implies the need for higher efficiency than now achieved in irrigation practice. Such shortage could eliminate any present small problems with tail water. It is not implied that there needs to be any regulations to achieve this. The water quality improvement efforts are bound to cause the cost of water to escalate. In such event, farmers can be depended upon to adopt the most efficient methods of irrigation possible.

Because lower rivers become more and more saline, the Lower Colorado River must also become more and more saline. This is even more applicable to the Salton Sea. It will cease, until there is another Lake Cahuilla, to be a habitat for fish, and its level can be expected to drop. This can also mean the loss of the Coachella open ditches as a habitat for fish.

Salt balance in Coachella Valley requires continuing studies on improving or maintaining productivity and soil conditions.

B. Nutrients

The nutrients going into the Coachella open drains are only sufficient to establish a reasonably good aquatic food web in the downstream waters. If there is desire to eliminate "algal blooms" from the Sea (the blue-green algae), the solution is not fewer nutrients, but to provide more DO in the urban liquid wastes, without any BOD. It is not an agricultural problem. Nitrogen is the primary nutrient of concern.

C. Pesticides

So far as now known, today only modest amounts of a few pesticide residues get into the Coachella open drains. Much more information must be obtained to determine whether or not there might be a problem. In any event, the dominant waters of these open drains are the effluents of tile drainage systems. The unsaturated flow of water through soil, that tile drainage provides, is the best environment in the world for the decomposition of pesticide residues, whether or not they are harmful to the downstream aquatic environment. If it is found that high pesticide residues exist, it is almost certain that they come from tail water, surreptitiously dumped into the ditches. In that case, elimination of this tail water would probably be BMP.

D. Dredging

Because of cost, the District does as little dredging as possible. If the District did not do this as needed, there would be no satisfactory outlets for the tile drainage system, no outlets for storm waters, and no longer a good aquatic environment to support fish life. Any turbidity of the ditch water provides the best evidence of surreptitiously discharged tail water.

E. Biological Controls

The continued use of *Tilapia zillii* and increasing use of biological controls will prove valuable in aquatic weed controls. A research project using the more temperature-tolerant white amur (Ctenopharyngodon idella) could be beneficial and cost-effective.

The above are the dominant areas of concern about the environment of Coachella Valley County Water District's open drains. All-in-all, the District is to be commended for creating such a fine environment as now exists for the farmers that it serves. It does not, and it should not, make any attempt to serve the itinerant and trespassing fisherman.

EXHIBIT A

TE OF CALIFORNIA
EXHIBIT A

S AGREEMENT, made and entered into this 17th day of February, 1978,
in State of California by and between State of California through its duly elected or appointed,
ified and acting

OF OFFICER ACTING FOR STATE	AGENCY	NUMBER
...ve Director	State Water Resources Control Board	7 947 17-8

...called the State, and

COACHELLA VALLEY COUNTY WATER DISTRICT

...called the Contractor.

...SSETH: That the Contractor for and in consideration of the covenants, conditions, agreements, and stipulations of the S... ...after expressed, does hereby agree to furnish to the State services and materials as follows:

(Set forth service to be rendered by Contractor, amount to be paid Contractor, time for performance or completion, and attach plans and specifications, if any.)

Contractor agrees to provide all labor, materials and equipment necessary to develop and evaluate alternative management practices relating to compatible uses of agricultural drains in accordance with the terms and conditions contained herein and all exhibits and addenda attached hereto.

The following documents are hereby incorporated and made a part of this agreement by reference: Exhibit "A", consisting of five (5) sheets; Exhibit "B", consisting of one (1) sheet, entitled Fair Employment Practices Addendum.

Total cost of this agreement shall not exceed $9,000.00, including all applicable State and local sales and use taxes.

Contractor shall provide services under this agreement from October 1, 1977 through June 30, 1978. Contractor shall not be entitled to payment for any work done prior to the above commencement date.

The services described herein are to be performed on behalf of California Regional Water Quality Control Board, Colorado River Basin Region.

...rovisions on the reverse side hereof constitute a part of this agreement.

...NESS WHEREOF, this agreement has been executed by the parties hereto, upon the date first above written.

STATE OF CALIFORNIA	CONTRACTOR
...e Water Resources Control Board	CONTRACTOR: Coachella Valley County Water District
AUTHORIZED SIGNATURE: Larry F. Walker, Executive Director, Water Quality	BY (AUTHORIZED SIGNATURE) / TITLE
	ADDRESS: Avenue 52 & Tyler, Coachella, CA 92236

Department of General Services Use ONLY	AMOUNT ENCUMBERED	APPROPRIATION	FUND		
MAR 14 1978	$ 9,000.00	Support	G.F. (Fed. 208 F.)		
	UNENCUMBERED BALANCE	ITEM	CHAPTER	STATUTES	FISCAL YEAR
	$	235	219	1977	1977-78
	ADJ. INCREASING ENCUMBRANCE	FUNCTION			FCC No.
	$	Operating Expenses & Equipment			150-02
	ADJ. DECREASING ENCUMBRANCE	LINE ITEM ALLOTMENT			Reg. 7
	$	281 Contract & Consultant Services			Allotmen...

I hereby certify upon my own personal knowledge that budgeted funds are available for the period and purpose of the expenditure stated above.

SIGNATURE OF ACCOUNTING OFFICER — DATE 2-17-78

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section ... have been complied with and this document is exempt from review by the Department of Finance.

Ass't. Chief Counsel

1. The Contractor agrees to indemnify, defend and save harmless the State, its officers, agents and employees from any and all claims and losses accruing or resulting to any and all contractors, subcontractors, materialmen, laborers and any other person, firm or corporation furnishing or supplying work, services, materials or supplies in connection with the performance of this contract, and from any and all claims and losses accruing or resulting to any person, firm or corporation who may be injured or damaged by the Contractor in the performance of this contract.

2. The Contractor, and the agents and employees of Contractor, in the performance of this agreement, shall act in an independent capacity and not as officers or employees or agents of State of California.

3. The State may terminate this agreement and be relieved of the payment of any consideration to Contractor should Contractor fail to perform the covenants herein contained at the time and in the manner herein provided. In the event of such termination the State may proceed with the work in any manner deemed proper by the State. The cost to the State shall be deducted from any sum due the Contractor under this agreement, and the balance, if any, shall be paid the Contractor upon demand.

4. Without the written consent of the State, this agreement is not assignable by Contractor either in whole or in part.

5. Time is the essence of this agreement.

6. No alteration or variation of the terms of this contract shall be valid unless made in writing and signed by the parties hereto, and no oral understanding or agreement not incorporated herein, shall be binding on any of the parties hereto.

7. The consideration to be paid Contractor, as provided herein, shall be in compensation for all of Contractor's expenses incurred in the performance hereof, including travel and per diem, unless otherwise expressly so provided.

EXHIBIT A TO STANDARD

AGREEMENT NO. 7 047 17-8

I. DEFINITIONS

A. The term "District" means Coachella Valley County Water District.

B. The term "Regional Board" means the California Regional Water Quality Control Board, Colorado River Basin Region.

C. The term "Project Director" means an employee of the Regional Board and of the District with duties as specified in Section VI below.

II. WORK TO BE PERFORMED

A. Development and Evaluation of Alternative Management Practices.

1. General. The District shall develop and evaluate alternative management practices for control of agricultural wastewater discharges from those lands in the Coachella Valley of California which are within the District, in order to maintain a water quality environment that will protect water oriented resources supported by agricultural drains while recognizing primary authoritative and contractural rights to the use of the agricultural drains.

2. Tasks. In performing the work required in Section II.A.1. hereof, the District shall develop and evaluate alternative management practices, including current management practices, for at least the following potential agricultural water quality problems:

a. Agricultural surface runoff water containing pesticides and fertilizers.

b. Water quality impacts due to mechanical dredging of agricultural drains.

c. Applications of herbicides and the use of aquatic herbivores for aquatic weed control in agricultural drains.

d. Discharges of agricultural runoff containing heavy silt loads or organic materials.

3. Procedures. The District shall review and evaluate monitoring data, developed by or on behalf of the Regional Board before or during the term of this agreement, concerning agricultural discharges to agricultural drains in the Coachella Valley. In performing the work required pursuant to Section II.A.1. and 2. hereof, the level of detail provided may vary among the potential water quality problems, commensurate with the relative severity of the problems and available planning resources.

B. Identification of Best Management Practices and Management Agencies to be Responsible for Implementation. For each of the potential water quality problems investigated pursuant to Section II.A. hereof, the District shall identify best management practices as defined by Title 40, Code of Federal Regulations, Section 130.2(q), and shall recommend appropriate management agencies to implement best management practices.

C. Environmental Impact Assessment.

1. For each potential water quality problem investigated pursuant to Section II.A. hereof, the District shall prepare a general assessment of social, economic and environmental impacts of alternative management practices.

2. The environmental impact assessment procedure shall generally be as follows:

   a. An initial study shall be conducted to determine what significant adverse effects on the environment could be caused by implementation of the alternative management practices.

   b. The initial study shall contain a general comparison of the management practices on the basis of social, economic, and environmental feasibility and acceptability.

   c. The assessment shall discuss ways to mitigate significant environmental effects identified in Section II.C.2.a. hereof.

   d. The assessment shall include an examination of the alternative management practices for compatibility with existing Federal, State, and local laws and regulations.

III. COORDINATION

The District shall coordinate the performance of work under the contract with the Regional Board staff. This coordination shall include, but is not limited to, attending meetings of the 208 Policy Advisory Committee for the Colorado River Basin Region when requested to attend by the Regional Board's Project Director, and attending all meetings of the Regional Agricultural Water Quality Advisory Committee during the term of the contract. The Regional Board's Project Director may also request that the District prepare presentations concerning the progress of this contract to be given to the above-mentioned committees.

IV. REPORTS

A. The District shall submit a written progress report to the Regional Board by April 7, 1978 (for the period from the effective date of the contract through March 31, 1978). The report shall describe all activities undertaken in the performance of work under this contract, shall indicate progress toward the development of best management practices, shall give an accounting of costs incurred during the reporting period together with invoices as required in Section VIII.B., and shall estimate the percentage of work completed as required hereunder. In addition, the progress report shall include an estimate of costs and accomplishments for the final reporting period.

B. On or before June 1, 1978, the District shall submit a final report to the Regional Board. The final report shall include a description of recommended best management practices for each of the problems specified in Section II.A. hereof, recommendations for designation of appropriate public agencies to implement best management practices, and the environmental assessment required pursuant to Section II.C. hereof.

V. DATA

A. All data developed pursuant to this contract shall be shared by the parties hereto and each party shall have the right to reproduce, publish, and use all such data or any part thereof in any manner and for any purposes whatsoever.

VI. PROJECT DIRECTORS

A. The Regional Board's Executive Officer shall be the Regional Board's Project Director for this Agreement.

B. The Regional Board's Project Director shall be the Regional Board's Representative for administration of the contract and shall have authority to make determinations and findings with respect to each question arising under or in connection with the interpretations, performance or payment for work performed under the contract. Contract interpretations shall be resolved in accordance with Section VII.

C. The District's Project Director shall be Keith Ainsworth. The District's Project Director shall be the District's Representative for administration of the contract and shall have full authority to act on behalf of the contractor. All communications given to the District's Project Director shall be as binding as if given to the District.

D. Either party may change its Project Director provided written notification is submitted to the other party at least two (2) weeks in advance of the change.

VII. CONTRACT INTERPRETATION

Except as otherwise provided in this contract, any contract interpretation concerning a question of fact arising under or relating to the performance of this contract which is not disposed of by agreement shall be decided by the Regional Board's Project Director, who shall reduce his decision to writing in regard to the contract interpretations and mail or otherwise furnish a copy thereof to the District, and the State Water Resources Control Board hereafter referred to as the State Board. If no objections are received from the State Board's authorized representative, the decision of the Regional Board's Project Director shall be final and conclusive unless, within thirty (30) days from the date of receipt of such copy, the District mails or otherwise furnishes the State Board or its duly authorized representative a written appeal. In connection with any appeal proceeding under this clause, the District shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a contract interpretation hereunder, the District shall proceed diligently with the performance of the contract and in accordance with the written decision of the Regional Board's Project Director which is the subject of the District's appeal.

VIII. COMPENSATION

A. Total compensation for all work performed under this agreement shall not exceed the sum of nine thousand dollars ($9,000.00).

B. Upon the submission of proper invoices the District shall be paid in two progress payments and a final payment. Progress payments shall not be more frequent than monthly and shall not exceed, in the aggregate, 75 percent of the total contract price, with the balance to be paid upon satisfactory completion of the contract.

C. The Report described in Section IV.B. hereof shall not be final until accepted. Upon acceptance of the Final Report and upon submission of an invoice entitled "Final Invoice", the District shall receive its final payment.

D. Invoices shall be submitted in triplicate to: Water Resources Control Board, Accounting Operations Section, P. O. Box 100, Sacramento, CA 95801. Invoices shall be subject to approval by the Regional Board's Project Director.

IX. TERM OF AGREEMENT

A. This Agreement shall take effect on October 1, 1977. This Agreement, unless terminated sooner in accordance with Section X hereof, shall remain in effect until June 30, 1978.

X. TERMINATION

A. This Agreement may be terminated by either party on thirty (30) days written notice. In the event of termination, the District shall be entitled to reasonable and necessary costs incurred prior to the effective date of termination.

Ex A-6

EXHIBIT "B" TO
WATER RESOURCES CONTROL BOARD
STANDARD AGREEMENT NO. 7 047 17-8
FAIR EMPLOYMENT PRACTICES ADDENDUM

1. In the performance of this contract, the Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, ancestry, sex*, age*, national origin, or physical handicap*. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, ancestry, sex*, age*, national origin, or physical handicap*. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by the State setting forth the provisions of this Fair Employment Practices section.

2. The Contractor will permit access to his records of employment, employment advertisements, application forms, and other pertinent data and records by the State Fair Employment Practices Commission, or any other agency of the State of California designated by the awarding authority, for the purposes of investigation to ascertain compliance with the Fair Employment Practices section of this contract.

3. Remedies for Willful Violation:

(a) The State may determine a willful violation of the Fair Employment Practices provision to have occurred upon receipt of a final judgment having that effect from a court in an action to which Contractor was a party, or upon receipt of a written notice from the Fair Employment Practices Commission that it has investigated and determined that the Contractor has violated the Fair Employment Practices Act and has issued an order, under Labor Code Section 1426, which has become final, or obtained an injunction under Labor Code Section 1429.

(b) For willful violation of this Fair Employment Practices provision, the State shall have the right to terminate this contract either in whole or in part, and any loss or damage sustained by the State in securing the goods or services hereunder shall be borne and paid for by the Contractor and by his surety under the performance bond, if any, and the State may deduct from any moneys due or that thereafter may become due to the Contractor, the difference between the price named in the contract and the actual cost thereof to the State.

*See Labor Code Sections 1411 - 1432.5 for further details.

E X H I B I T S

E-1 TO E-8

GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 313015 RECORD # 47871

SAMPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
STATION ID: 313015 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771031 END-- TIME--
STATE CODE: 06 COUNTY CODE: 037 PROJECT IDENTIFICATION: 479300300
DATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
COMMENTS:
ARTHUR ST TILE DRAIN. ATT ECCLES.

ALDRIN TOTAL (WATER)	UG/L	0.00	MERCURY TOTAL	UG/L	0.
CHLORDANE TOT(WATER)	UG/L	0.0	MET PARTH TOT(WATER)	DETR.	DELET
COPPER TOTAL	UG/L	< 10	MET TRITH TOT(WATER)	DETR.	DELET
DDD TOTAL (WATER)	UG/L	0.00	NITROGEN NH4 ASN TOT	MG/L	0.
DDE TOTAL (WATER)	UG/L	0.00	NITROGEN TOT ORG N	MG/L	0.
DDT TOTAL (WATER)	UG/L	0.01	NITROGEN TOTKJD AS N	MG/L	0.
DIAZINON TOT (WATER)	DETR.	DELETED	PCB TOTAL (WATER)	UG/L	0.
DIELDRIN TOT (WATER)	UG/L	0.01	PCN TOTAL (WATER)	UG/L	0.
ENDOSULFAN TOTAL	UG/L	0.00	PERTHANE TOTAL	UG/L	0.
ENDRIN TOTAL (WATER)	UG/L	0.00	SAMPLE SOURCE CODE		40
ETH PARTH TOT(WATER)	DETR.	DELETED	SILVEX TOTAL (WATER)	UG/L	0.
ETH TRITH TOT(WATER)	DETR.	DELETED	SP. CONDUCTANCE FLD		5050
ETHION TOTAL (WATER)	DETR.	DELETED	TOXAPHENE TOT(WATER)	UG/L	0.
HEPT EPOX TOT(WATER)	UG/L	0.00	WATER TEMP (DEG C)		25.
HEPTACHLOR T.(WATER)	UG/L	0.00	ZINC TOTAL	UG/L	8
LINDANE TOTAL(WATER)	UG/L	0.00	2,4-D TOTAL (WATER)	UG/L	0.
MALATHION TOT(WATER)	DETR.	DELETED	2,4-DP TOTAL (WATER)	UG/L	0.
			2,4,5-T TOTAL(WATER)	UG/L	0.

(EXHIBITS E-1 TO E-8)

EXHIBIT E-1

CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 67502 RECORD # 2949

MPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
TION ID: 067502 LAT.LONG.SEQ.: * NONE GIVEN *
OF COLLECTION: BEGIN--780227 END-- TIME--1600
ATE CODE: 06 COUNTY CODE: 065 PROJECT IDENTIFICATION: 479300300
TA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
MMENTS:
ARTHUR ST DRAIN, ATT ECCLES

DRIN TOTAL (WATER)	UG/L	0.00	LINDANE TOTAL(WATER)	UG/L	0.00
LORDANE TOT(WATER)	UG/L	0.0	MALATHION TOT(WATER)	UG/L	0.00
LORPYRIFOS TOTAL	UG/L	0.00	MET PARTH TOT(WATER)	UG/L	0.00
D TOTAL (WATER)	UG/L	0.00	MET TRITH TOT(WATER)	UG/L	0.00
E TOTAL (WATER)	UG/L	0.01	PCB TOTAL (WATER)	UG/L	0.0
T TOTAL (WATER)	UG/L	0.00	PCN TOTAL (WATER)	UG/L	0.0
AZINON TOT (WATER)	UG/L	0.00	PERTHANE TOTAL	UG/L	0.00
ELDRIN TOT (WATER)	UG/L	0.00	PH FIELD		7.7
DOSULFAN I TOTAL	UG/L	0.00	SAMPLE SOURCE CODE		40
DRIN TOTAL (WATER)	UG/L	0.00	SILVEX TOTAL (WATER)	UG/L	0.00
H PARTH TOT(WATER)	UG/L	0.00	SP. CONDUCTANCE FLD		4900
H TRITH TOT(WATER)	UG/L	0.00	TOXAPHENE TOT(WATER)	UG/L	0.0
HION TOTAL (WATER)	UG/L	0.00	WATER TEMP (DEG C)		22.0
PT EPOX TOT(WATER)	UG/L	0.00	2,4-D TOTAL (WATER)	UG/L	0.00
CHLOR T.(WATER)	UG/L	0.00	2,4-DP TOTAL (WATER)	UG/L	0.00
			2,4,5-T TOTAL(WATER)	UG/L	0.00

EXHIBIT E-2

GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID = 313018 RECORD = 47877

SAMPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
STATION ID: 313018 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771031 END-- TIME--
STATE CODE: 06 COUNTY CODE: 037 PROJECT IDENTIFICATION: 479300300
DATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
COMMENTS:
OASIS-LINCOLN ST TILE DRAIN. ATT ECCLES.

ALDRIN TOTAL (WATER)	UG/L	0.00
CHLORDANE TOT(WATER)	UG/L	0.0
COPPER TOTAL	UG/L <	10
DDD TOTAL (WATER)	UG/L	0.00
DDE TOTAL (WATER)	UG/L	0.00
DDT TOTAL (WATER)	UG/L	0.00
DIAZINON TOT (WATER)		DETR. DELETED
DIELDRIN TOT (WATER)	UG/L	0.01
ENDOSULFAN TOTAL	UG/L	0.00
ENDRIN TOTAL (WATER)	UG/L	0.00
ETH PARTH TOT(WATER)		DETR. DELETED
ETH TRITH TOT(WATER)		DETR. DELETED
ETHION TOTAL (WATER)		DETR. DELETED
HEPT EPOX TOT(WATER)	UG/L	0.00
HEPTACHLOR T.(WATER)	UG/L	0.00
LINDANE TOTAL(WATER)	UG/L	0.00
MALATHION TOT(WATER)		DETR. DELETED
MERCURY TOTAL	UG/L	0.
MET PARTH TOT(WATER)		DETR. DELET
MET TRITH TOT(WATER)		DETR. DELET
NITROGEN NH4 ASN TOT	MG/L	0.
NITROGEN TOT ORG N	MG/L	1.
NITROGEN TOTKJD AS N	MG/L	1.
PCB TOTAL (WATER)	UG/L	0.
PCN TOTAL (WATER)	UG/L	0.
PERTHANE TOTAL	UG/L	0.
SAMPLE SOURCE CODE		40
SILVEX TOTAL (WATER)	UG/L	0.
SP. CONDUCTANCE FLD		2850
TOXAPHENE TOT(WATER)	UG/L	0.
WATER TEMP (DEG C)		26.
ZINC TOTAL	UG/L	10
2,4-D TOTAL (WATER)	UG/L	0.
2,4-DP TOTAL (WATER)	UG/L	0.
2,4,5-T TOTAL(WATER)	UG/L	0.

EXHIBIT E-3

CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 67506 RECORD # 2957

MPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
ATION ID: 067506 LAT.LONG.SEQ.: * NONE GIVEN *
A[illegible] OF COLLECTION: BEGIN--780227 END-- TIME--1505
TATE CODE: 06 COUNTY CODE: 065 PROJECT IDENTIFICATION: 479300300
ATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
OMMENTS:
OASIS-LINCOLN ST DRAIN: ATT ECCLES

LDRIN TOTAL (WATER) UG/L	0.00	LINDANE TOTAL(WATER) UG/L	0.00
HLORDANE TOT(WATER) UG/L	0.0	MALATHION TOT(WATER) UG/L	0.00
HLORPYRIFOS TOTAL UG/L	0.00	MET PARTH TOT(WATER) UG/L	0.00
DD TOTAL (WATER) UG/L	0.00	MET TRITH TOT(WATER) UG/L	0.00
DE TOTAL (WATER) UG/L	0.01	PCB TOTAL (WATER) UG/L	0.0
DT TOTAL (WATER) UG/L	0.00	PCN TOTAL (WATER) UG/L	0.0
IAZINON TOT (WATER) UG/L	0.00	PERTHANE TOTAL UG/L	0.00
IELDRIN TOT (WATER) UG/L	0.00	PH FIELD	7.3
NDOSULFAN I TOTAL UG/L	0.00	SAMPLE SOURCE CODE	40
NDRIN TOTAL (WATER) UG/L	0.00	SILVEX TOTAL (WATER) UG/L	0.86
TH PARTH TOT(WATER) UG/L	0.00	SP. CONDUCTANCE FLD	2800
TH TRITH TOT(WATER) UG/L	0.00	TOXAPHENE TOT(WATER) UG/L	0.0
THION TOTAL (WATER) UG/L	0.00	WATER TEMP (DEG C)	20.0
EPT EPOX TOT(WATER) UG/L	0.00	2,4-D TOTAL (WATER) UG/L	0.00
ACHLOR T.(WATER) UG/L	0.00	2,4-DP TOTAL (WATER) UG/L	0.00
		2,4,5-T TOTAL(WATER) UG/L	0.01

EXHIBIT E-4

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID = 313017 RECORD = 47874

SAMPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
STATION ID: 313017 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771031 END-- TIME--
STATE CODE: 06 COUNTY CODE: 037 PROJECT IDENTIFICATION: 479300300
DATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
COMMENTS:
AVE 50 TILE DRAIN. ATT ECCLES.

ALDRIN TOTAL (WATER)	UG/L	0.00	MERCURY TOTAL	UG/L	0.1
CHLORDANE TOT(WATER)	UG/L	0.0	MET PARTH TOT(WATER)	DETR. DELETE	
COPPER TOTAL	UG/L <	10	MET TRITH TOT(WATER)	DETR. DELETE	
DDD TOTAL (WATER)	UG/L	0.00	NITROGEN NH4 ASN TOT	MG/L	0.1
DDE TOTAL (WATER)	UG/L	0.00	NITROGEN TOT ORG N	MG/L	0.5
DDT TOTAL (WATER)	UG/L	0.00	NITROGEN TOTKJD AS N	MG/L	0.6
DIAZINON TOT (WATER)	DETR. DELETED		PCB TOTAL (WATER)	UG/L	0.0
DIELDRIN TOT (WATER)	UG/L	0.02	PCN TOTAL (WATER)	UG/L	0.0
ENDOSULFAN TOTAL	UG/L	0.00	PERTHANE TOTAL	UG/L	0.0
ENDRIN TOTAL (WATER)	UG/L	0.01	SAMPLE SOURCE CODE		40
ETH PARTH TOT(WATER)	DETR. DELETED		SILVEX TOTAL (WATER)	UG/L	0.0
ETH TRITH TOT(WATER)	DETR. DELETED		SP. CONDUCTANCE FLD		2250
ETHION TOTAL (WATER)	DETR. DELETED		TOXAPHENE TOT(WATER)	UG/L	0.0
HPT EPOX TOT(WATER)	UG/L	0.00	WATER TEMP (DEG C)		25.0
HEPTACHLOR T.(WATER)	UG/L	0.00	ZINC TOTAL	UG/L	10
LINDANE TOTAL(WATER)	UG/L	0.00	2,4-D TOTAL (WATER)	UG/L	0.0
MALATHION TOT(WATER)	DETR. DELETED		2,4-DP TOTAL (WATER)	UG/L	0.0
			2,4,5-T TOTAL(WATER)	UG/L	0.0

EXHIBIT E-5

CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 67510 RECORD # 2965

.PLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
ATION ID: 067510 LAT.LONG.SEQ.: * NONE GIVEN *
T OF COLLECTION: BEGIN--780227 END-- TIME--1330
ATE CODE: 06 COUNTY CODE: 065 PROJECT IDENTIFICATION: 479300300
TA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
MMENTS:
AVENUE 50 DRAIN; EST Q = 120 GPM; ATT ECCLES

DRIN TOTAL (WATER)	UG/L	0.00	LINDANE TOTAL(WATER)	UG/L	0.00
LORDANE TOT(WATER)	UG/L	0.0	MALATHION TOT(WATER)	UG/L	0.00
LORPYRIFOS TOTAL	UG/L	0.00	MET PARTH TOT(WATER)	UG/L	0.00
D TOTAL (WATER)	UG/L	0.00	MET TRITH TOT(WATER)	UG/L	0.00
E TOTAL (WATER)	UG/L	0.00	PCB TOTAL (WATER)	UG/L	0.0
T TOTAL (WATER)	UG/L	0.00	PCN TOTAL (WATER)	UG/L	0.0
AZINON TOT (WATER)	UG/L	0.00	PERTHANE TOTAL	UG/L	0.00
ELDRIN TOT (WATER)	UG/L	0.01	PH FIELD		7.6
IDOSULFAN I TOTAL	UG/L	0.00	SAMPLE SOURCE CODE		40
IDRIN TOTAL (WATER)	UG/L	0.00	SILVEX TOTAL (WATER)	UG/L	0.00
H PARTH TOT(WATER)	UG/L	0.00	SP. CONDUCTANCE FLD		1660
H TRITH TOT(WATER)	UG/L	0.00	TOXAPHENE TOT(WATER)	UG/L	0.0
HION TOTAL (WATER)	UG/L	0.00	WATER TEMP (DEG C)		20.0
PT EPOX TOT(WATER)	UG/L	0.00	2,4-D TOTAL (WATER)	UG/L	0.00
ACHLOR T.(WATER)	UG/L	0.00	2,4-DP TOTAL (WATER)	UG/L	0.00
			2,4,5-T TOTAL(WATER)	UG/L	0.00

EXHIBIT E-6

GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 313015 RECORD # 47868

SAMPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
STATION ID: 313015 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771031 END-- TIME--
STATE CODE: 06 COUNTY CODE: 037 PROJECT IDENTIFICATION: 479300300
DATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
COMMENTS:
AVE 56 TILE DRAIN. ATT ECCLES.

ALDRIN TOTAL (WATER)	UG/L	0.00	MERCURY TOTAL	UG/L	0.1
CHLORDANE TOT(WATER)	UG/L	0.0	MET PARTH TOT(WATER)	DETR. DELETE	
COPPER TOTAL	UG/L	< 10	MET TRITH TOT(WATER)	DETR. DELETE	
DDD TOTAL (WATER)	UG/L	0.00	NITROGEN NH4 ASN TOT	MG/L	0.0
DDE TOTAL (WATER)	UG/L	0.00	NITROGEN TOT ORG N	MG/L	0.4
DDT TOTAL (WATER)	UG/L	0.00	NITROGEN TOTKJD AS N	MG/L	0.-
DIAZINON TOT (WATER)	DETR. DELETED		PCB TOTAL (WATER)	UG/L	0.0
DIELDRIN TOT (WATER)	UG/L	0.01	PCN TOTAL (WATER)	UG/L	0.0
ENDOSULFAN TOTAL	UG/L	0.00	PERTHANE TOTAL	UG/L	0.0
ENDRIN TOTAL (WATER)	UG/L	0.00	SAMPLE SOURCE CODE		40
ETH PARTH TOT(WATER)	DETR. DELETED		SILVEX TOTAL (WATER)	UG/L	0.0
ETH TRITH TOT(WATER)	DETR. DELETED		SP. CONDUCTANCE FLD		2380
ETHION TOTAL (WATER)	DETR. DELETED		TOXAPHENE TOT(WATER)	UG/L	0.0
HPT EPOX TOT(WATER)	UG/L	0.00	WATER TEMP (DEG C)		24.0
HEPTACHLOR T.(WATER)	UG/L	0.00	ZINC TOTAL	UG/L	0
LINDANE TOTAL(WATER)	UG/L	0.00	2,4-D TOTAL (WATER)	UG/L	0.0
MALATHION TOT(WATER)	DETR. DELETED		2,4-DP TOTAL (WATER)	UG/L	0.0
			2,4,5-T TOTAL(WATER)	UG/L	0.0

EXHIBIT E-7

CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 67503 RECORD # 2951

MPLE LOCATION: "NO INFORMATION IN THE STATION HEADER FILE."
TATION ID: 067503 LAT.LONG.SEQ.: * NONE GIVEN *
OF COLLECTION: BEGIN--780227 END-- TIME--1405
TATE CODE: 06 COUNTY CODE: 065 PROJECT IDENTIFICATION: 479300300
ATA TYPE: 2 SOURCE: OTHER GEOLOGIC UNIT:
OMMENTS:
AVENUE 56 DRAIN; ATT ECCLES

LDRIN TOTAL (WATER) UG/L	0.00	LINDANE TOTAL(WATER) UG/L	0.0(
HLORDANE TOT(WATER) UG/L	0.0	MALATHION TOT(WATER) UG/L	0.0(
HLORPYRIFOS TOTAL UG/L	0.00	MET PARTH TOT(WATER) UG/L	0.0(
DD TOTAL (WATER) UG/L	0.00	MET TRITH TOT(WATER) UG/L	0.0(
DE TOTAL (WATER) UG/L	0.01	PCB TOTAL (WATER) UG/L	0.0
DT TOTAL (WATER) UG/L	0.00	PCN TOTAL (WATER) UG/L	0.0
IAZINON TOT (WATER) UG/L	0.00	PERTHANE TOTAL UG/L	0.0(
IELDRIN TOT (WATER) UG/L	0.00	PH FIELD	7.3
NDOSULFAN I TOTAL UG/L	0.00	SAMPLE SOURCE CODE	40
NDRIN TOTAL (WATER) UG/L	0.00	SILVEX TOTAL (WATER) UG/L	0.0
TH PARTH TOT(WATER) UG/L	0.00	SP. CONDUCTANCE FLD	2250
TH TRITH TOT(WATER) UG/L	0.00	TOXAPHENE TOT(WATER) UG/L	0.0
THION TOTAL (WATER) UG/L	0.00	WATER TEMP (DEG C)	20.5
EPT EPOX TOT(WATER) UG/L	0.00	2,4-D TOTAL (WATER) UG/L	0.0
TACHLOR T.(WATER) UG/L	0.00	2,4-DP TOTAL (WATER) UG/L	0.0
		2,4,5-T TOTAL(WATER) UG/L	0.0

EXHIBIT E-8

EXHIBIT E-9

ORDINANCE NO 958

COACHELLA VALLEY COUNTY WATER DISTRICT

AN ORDINANCE OF THE COACHELLA VALLEY COUNTY WATER DISTRICT RELATING TO THE DELIVERY AND USE OF DISTRICT WATER, PROVIDING FOR THE ESTABLISHMENT OF RATE SCHEDULES FROM TIME TO TIME, FOR BILLING AND COLLECTING PURSUANT TO SAID RATE SCHEDULES, AND FOR OTHER PURPOSES

BE IT ORDAINED by the Board of Directors of the Coachella Valley County Water District, as follows:

SECTION 1 - INITIAL APPLICATION FOR WATER

(a) Before any water is delivered by the District, each landowner must fill out, sign and file with the District an "Application for Water by Landowner," for each parcel of land for which he desires water. This application shall indicate the particular land or lands owned by the applicant which are to receive water and shall also designate the name or names of those persons who will have authority subsequently to place water orders under the application. The required application form may be procured at the District office.

(b) Whenever the person or persons who are to have authority to place water orders under an application are to be changed or whenever ownership of a parcel of land is changed, a new application for water must be filled out, signed and filed with the District.

(c) The landowner shall provide a right of way for access road to meter and valves for operational and maintenance purposes.

(d) Water will be delivered only through District approved service connections.

(e) There shall be installed by the landowner prior to any delivery, an adequate overflow or constant head stand approved by the District.

SECTION 2 - DEPOSITS

In case of public lands under lease or lands held by desert-entry, entryman recognized as such by the United States Bureau of Land Management,

EXHIBIT E-9

an "Application for Water by Other than Landowner" may be received and may be granted in the discretion of the Board, upon the precedent condition, however, that a deposit shall be made with the District to guarantee all tolls and charges; deposit shall be returned upon termination of water service, less any amount then due and owing. The amount of deposit to be made will be set by the Board at time of approval of application for water.

SECTION 3 - WATER ORDERS

(a) All water orders must be placed with the office of the Water Department of the District during normal business hours. The District assumes no responsibility for errors arising from orders which are not submitted in writing.

(b) Water orders may be placed only by an authorized person and must include the following information:

1. Meter number
2. Name of landowner
3. Name of authorized person placing the order
4. The quantity of water and the period of time during which said order is to be effective.

(c) On the day upon which the order is to be put into effect, the zanjero will turn water on or off or make changes at the time when he passes the point of delivery on his regular scheduled run for that day.

(d) Delivered water as ordered will run continuously day and night until ordered off. Water orders will not be accepted for runs of less than twenty-four (24) hours, and must be in multiples of 24 hours. Requests for cancellation which are placed after normal business hours on the day preceding the day upon which an order is to become effective will be received and honored only as an unscheduled change.

(e) Where the demand for water exceeds the capacity of the facilities, water shall be delivered in sequence to water users pursuant to orders received at the maximum rate of flow available or as much thereof as the water user shall order. Twelve (12) days shall be the maximum period of time for a complete cycle during which all affected water users are served. The amount of time allotted to each water user shall bear the same ratio as his acreage bears to the total acreage involved, provided that the shortest length of time for a given delivery shall be one (1) day. Should all of the water users involved in a rotation water schedule agree among themselves to a schedule other than above and submit such schedule in writing, the Board of Directors or the General Manager may approve same if it does not conflict with existing rules and regulations.

(f) Where the demand for water exceeds the available water supply within the canal, water orders may be delayed two days, however, all orders will be honored within that period of time except those water users who are on a rotation schedule, except under emergency conditions as determined by the District.

SECTION 4 - UNSCHEDULED ORDERS

In addition to the current water tolls, there shall be a special service charge made for each unscheduled order, amount of charge being set forth in Rate Schedules as referred to in Section 5. Unscheduled orders are generally defined as follows:

(a) When a turn-off or decrease order is placed with the Water Department after normal business hours of the day preceding that in which the order is to become effective and prior to the time the zanjero begins his regular work on the lateral which the order affects.

(b) When a turn-off or decrease order is placed with the office of the Water Department after the zanjero has commenced work on the lateral, or the order affects a lateral which has already been "set-up",

(c) When a turn-on or increase order is placed after normal business hours and prior to the time when the zanjero begins his daily work, or has already commenced work on the lateral on which the delivery is to be made.

All unscheduled orders are subject to the availability of water in the lateral involved and the ability of the District's personnel to perform the additional work.

SECTION 5 - RATE SCHEDULES

All charges for water furnished to a water user will be made as set forth in the Rate Schedules established from time to time by the Board of Directors of the Coachella Valley County Water District. Copies of these Rate Schedules are available for inspection at the District office.

SECTION 6 - BILLING, DELINQUENCIES, TERMINATION & RENEWAL OF SERVICE

(a) During each calendar month the District shall mail a statement covering charges for all water delivered during the preceding calendar month which charges shall be due and payable immediately. If such charges are not paid by the last day of the month in which billed, two per cent (2%) penalty shall be added to the amount of the bill and an additional two per cent (2%) shall be added for each month thereafter that the bill remains unpaid. If charges billed are not paid by the 10th day of the month succeeding the month in which billed, they shall become delinquent, following which the District shall, without further notice, discontinue service until such charges are paid in full. Whether or not the statement covering charges, as in this Section provided, is actually delivered to the person responsible for the payment thereof is not controlling, the amount of said charges being due and owing to the District whether or not the statement therefor is actually delivered.

(b) Any applicant whose application for water is filed pursuant to Sections 1 and 2 of this Ordinance, which application is accepted by the District and under which application water is furnished by the District as provided herein, becomes liable for payment under the appropriate rate schedule for all water or services so furnished by the District, as provided herein, subsequent to the date stipulated on the authorization and until such time as the applicant makes proper request to the District to cancel the authorization. It is understood that the District delivers water through its works and meters and charges for all water delivered through each meter. In the event that water service is interrupted or discontinued by the District because of the failure of the applicant or the water user to pay the charges therefor, said service shall not be restored nor shall water again be delivered through the meter or to the land involved unless and until all charges which are delinquent have been paid in full. Change in ownership of land shall in no way cause a modification hereof, it being the intent and purpose of this provision that once a delinquency has occurred, no further water will be delivered through the involved meter to the concerned land, even though ownership of the land has changed, unless and until all delinquencies have been paid in full.

SECTION 7 - USE OF RIGHTS OF WAY, PIPE LINES AND STRUCTURES

According to easements granted by landowners for construction of laterals and turn-out structures on or across their property, the landowner has the right to farm all land over District laterals; however, permission is not granted to operate this land in any manner which might injure the pipe lines therein. No fences or other obstructions should be constructed which would interfere with normal operation and maintenance of main laterals.

This should not be construed as giving permission to farm, fence or make installations of any kind on the right of way along the open canal which might interfere with the travel of maintenance equipment along same.

The roads on the main canal are not public roads, but are to be used only for the operation and maintenance of the canal system.

Swimming in any of the water system facilities is strictly forbidden.

The structures and lines of the District system shall not be used for the application of fertilizer or any other uses which might either damage or interfere with the operation of the system. Open irrigation ditches or reservoirs are not to be constructed on top of District pipe lines.

SECTION 8 - BENEFICIAL USE - WASTE OF WATER

(a) Water is ordered from the District with the express stipulation by the water user that water delivered will be restricted to an amount which can be beneficially used within the confines of the property described in the application. Water will be delivered only to lands eligible to receive and use District water.

(b) The District will refuse or restrict water service to any landowner or water user where wasting of water occurs.

SECTION 9 - COMPENSATION TO DISTRICT EMPLOYEES

All inspectors, agents and employees of the District, while acting as such, are strictly forbidden to demand or accept any personal compensation for services rendered to a water user of the District.

SECTION 10 - INTERFERENCE BY UNAUTHORIZED PERSONS

No water shall be delivered except through works controlled by the District. No person shall molest, tamper or interfere with structures used for the delivery of water.

ORDINANCE NO. 958

COACHELLA VALLEY COUNTY WATER DISTRICT

SECTION 11 - VIOLATION OF THE PROVISIONS OF THIS ORDINANCE

Except as otherwise herein provided water service may be discontinued without notice upon violation of any of the provisions of this Ordinance, in which event service will be restored only upon order of the Board and upon such conditions as the Board may determine.

SECTION 12 - REPEALS

Ordinances No. 860, 865, 868, 869, and 871, as well as any other Ordinances or parts of Ordinances in conflict with the provisions of this Ordinance, are hereby expressly repealed.

SECTION 13 - EFFECTIVE DATE

This Ordinance shall become effective on the first day of July, 1964.

President of the Board of Directors of Said District

I, the undersigned secretary of the COACHELLA VALLEY COUNTY WATER DISTRICT, do hereby certify that the foregoing is a true and correct copy of Ordinance No. 958 of said District, introduced and passed at meeting of said Board held June 9, 1964, and that said Ordinance was passed by the following vote:

Ayes:	Five
Directors:	Frost, Rummonds, Bromley, Leach, Kennedy
Noes:	None
Absent:	None

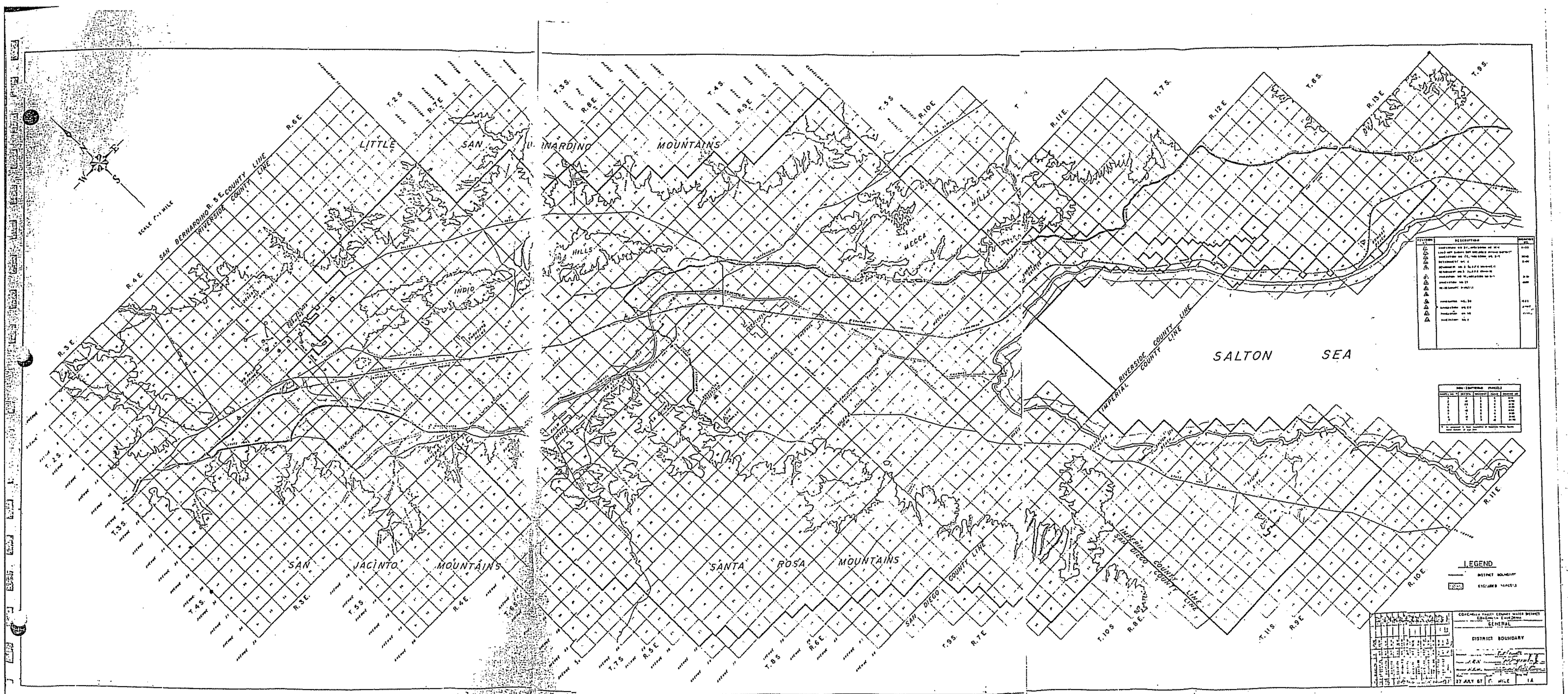
I further certify that said Ordinance was thereupon signed by the president of the Board of Directors of said District.

Attest:

Secretary of said District.

E-9-7

M A P S


LITTLE SAN BERNARDINO MOUNTAINS
SAN BERNARDINO COUNTY LINE
RIVERSIDE COUNTY LINE
INDIO HILLS
MECCA HILLS
SALTON SEA
RIVERSIDE COUNTY LINE
IMPERIAL COUNTY LINE
SAN JACINTO MOUNTAINS
SANTA ROSA MOUNTAINS
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IMPERIAL COUNTY LINE
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R. 9 E.
R. 10 E.
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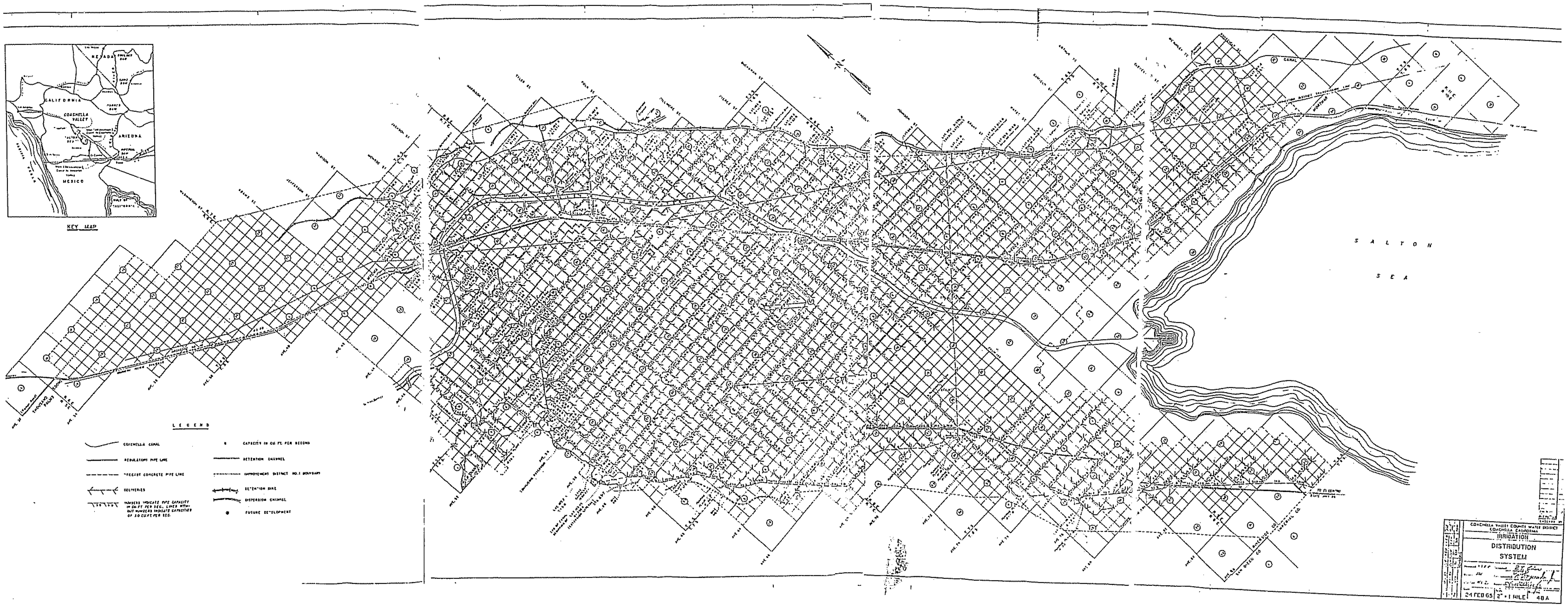
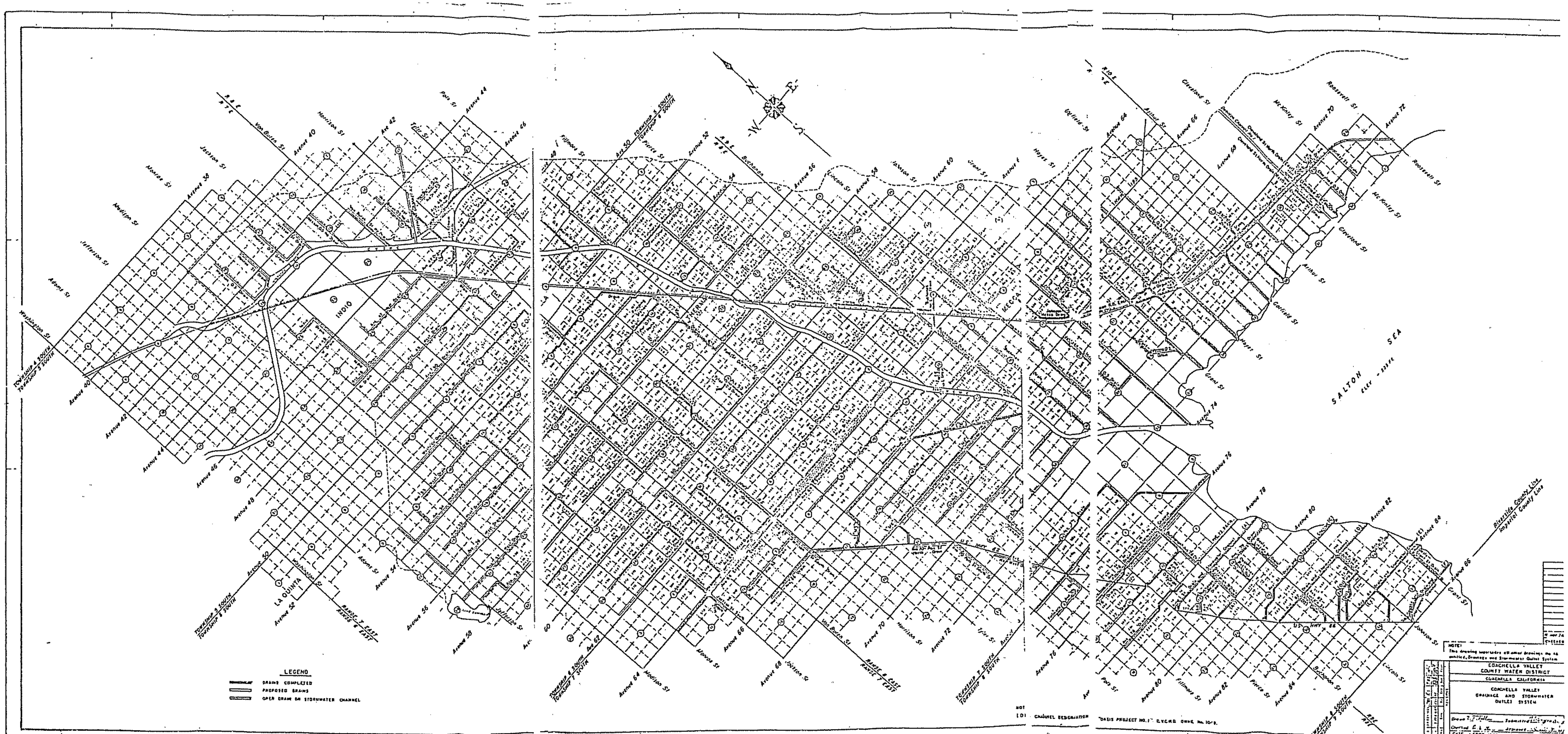
R. 12 E.
R. 13 E.
LEGEND
DISTRICT BOUNDARY
GENERAL
DISTRICT BOUNDARY
27 JULY 67
1A


KEY MAP
CALIFORNIA
NEVADA
ARIZONA
MEXICO
COACHELLA VALLEY
SALTON SEA
LEGEND
COACHELLA CANAL
REGULATORY PIPE LINE
PRECAST CONCRETE PIPE LINE
DELIVERIES
NUMBERS INDICATE PIPE CAPACITY IN CU.FT. PER SEC., LINES WITHOUT NUMBERS INDICATE CAPACITIES OF 3.0 CU.FT. PER SEC.
CAPACITY IN CU. FT. PER SECOND
RETENTION CHANNEL
IMPROVEMENT DISTRICT NO.1 BOUNDARY
RETENTION DIKE
DISPERSION CHANNEL
FUTURE DEVELOPMENT
COACHELLA VALLEY COUNTY WATER DISTRICT
COACHELLA, CALIFORNIA
IRRIGATION
DISTRIBUTION
SYSTEM
24 FEB 65
2" = 1 MILE
48 A



INDIO
LA QUINTA
MECCA
THERMAL
SALTON SEA
ELEV. -235 FT.
Washington St
Adams St
Jefferson St
Madison St
Monroe St
Jackson St
Van Buren St
Harrison St
Tyler St
Polk St
Fillmore St
Pierce St
Buchanan St
Lincoln St
Johnson St
Grant St
Hayes St
Arthur St
Cleveland St
McKinley St
Roosevelt St
Avenue 38
Avenue 40
Avenue 42
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Avenue 46
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Avenue 80
Avenue 82
Avenue 84
Avenue 86
TOWNSHIP 5 SOUTH
TOWNSHIP 6 SOUTH
TOWNSHIP 7 SOUTH
TOWNSHIP 8 SOUTH
RANGE 7 EAST
RANGE 8 EAST
Riverside County Line
Imperial County Line
U.S. HWY 99
N
E
S
W
LEGEND
DRAINS COMPLETED
PROPOSED DRAINS
OPEN DRAIN OR STORMWATER CHANNEL
CHANNEL DESIGNATION "OASIS PROJECT NO. 1" C.V.C.W.D. DWG. No. 10-9.
NOTE:
This drawing supersedes all other drawings ... Drainage and Stormwater Outlet System
COACHELLA VALLEY
COUNTY WATER DISTRICT
COACHELLA CALIFORNIA
COACHELLA VALLEY
DRAINAGE AND STORMWATER
OUTLET SYSTEM
Drawn
Submitted
Checked
Approved
DATE SEPT 1948
DRAWING NO.

APPENDIX A

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(56) William M. Bailey and Randy L. Boyd, Fishery Biologists, <u>Arkansas Game and Fish Commission</u>, various reports and observations on White Amur, 1972 and 1977 tour with William T. Haller, <u>University of Florida to Southeast Asia</u>, and 1973 report to <u>American Fisheries Society</u> Vol. 102, No. 1, January 1973 by Walter R. Courtenay, Jr., and C. Richard Robins, Florida biologists.